Drawing Room Chairs.

Designed by M.A.Nicholson.

Tingle sculp.

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THE CABINET MAKER, UPHOLSTERER, AND COMPLETE DECORATOR,

WITH GEOMETRICAL SECTIONS,

AND FURNITURE COLOURED ENGRAVINGS,

AND A

PERFECT GLOSSARY OF TECHNICAL TERMS USED IN CABINET MAKING,

BY

PETER NICHOLSON.

London: FISHER & CAXTON.
1826.

INTRODUCTION.

THE want of a complete treatise, by the aid of which all the various articles of CABINET FURNITURE may be readily executed by the Mechanic with precision and tasteful elegance, and the designs made clearly intelligible to the Gentleman and the Amateur, has been long and sensibly felt as a serious inconvenience. Aware of this deficiency, the principal object of the Author, in the following Essay, is to supply the desideratum, by furnishing such a variety of designs as shall illustrate the principles upon which these articles are constructed, and afford every requisite information on this important and interesting subject. Before, however, he proceeds to enumerate the contents of this work, it may be necessary for him to prepare in some degree the mind of the reader for an advantageous perusal, by pointing out to him the nature and extent of his scientific researches.

In the construction of objects, our first and chief consideration is utility; but when our actual wants are fully supplied, we naturally seek further gratification in their varied forms and external ornaments; yet in the choice of figure, we must, nevertheless, be always governed by certain criteria, founded upon peculiar associations. It is one of the grand designs of this treatise to put the reader in possession of these principles, as they will prove eminently useful to him, both as an artisan and an amateur, by directing his attention to classic forms and tasteful embellishments.

Every sensible object in the phenomena of surrounding nature, must necessarily be contained under some external form and appearance. But as it is desirable that the eye should be pleased, and the imagination gratified, the particular figure under which a thing presents itself can never be a matter of indifference; for it is a well-known fact, that while the contour of some

bodies communicate agreeable sensations, others are incapable of producing any; while many again are wholly repugnant to every possible agreement with our feelings and ideas. But indeed, allowing, even in this instance, that we were satisfied, the illusion would not be lasting. The charm of novelty is gradually dissolved, and a repetition of the same object, however pleasing at first, soon loses its effect, and in the course of time ceases altogether to attract or delight.

In order, therefore, to rouse the dormant spirit of curiosity, and rekindle the dying embers of exhausted pleasure, it becomes necessary to seek out fresh sources of intellectual gratification; and thus the powerful and inventive genius of man is called forth, and kept in constant and persevering exertion. It is a trite and oft-repeated observation, that "there is nothing new under the sun;" hence many imagine that every possible variety has already been discovered; that nature at length is completely exhausted; and that nothing further remains to be produced. This, however, is far from the truth; since although the number of forms may in some degree be said to be limited, their combinations are almost infinite. It is a knowledge of this interesting fact, that enables us to construct new figures, and to fashion them according to our desire; yet our taste must at all times be governed by certain principles, that are fixed upon as sure a foundation as are the sublime propositions contained in the Elements of Euclid. We shall therefore endeavour to establish some specific rule by which our judgment may invariably be directed, and which may serve both as a test of merit and as a standard of excellence.

A judicious selection, then, of the beautiful forms and varieties of nature, and a strict adherence to curve lines produced by organical description, ought to constitute our elements of taste.*

It was a knowledge of these principles that inspired the genius of the illustrious artisans of Greece, and enabled them to construct those sublime works, which remain, even to this day, the proud and lofty monuments of unrivalled excellence and universal admiration. The labours of remote antiquity would never have been held in such profound veneration, had not the scientific principles, which guided the hand of the artist, been clearly visible in those splendid examples that have been handed down to posterity, and have hitherto withstood the destroying hand of time.

* The pleasing forms and wonderful variety of systems of curves, produced by Mr. Jopling's ingenious contrivances, originally suggested by an article in the IMPERIAL MAGAZINE for 1822, are truly astonishing.

A careful and an attentive study, therefore, of the works of the ancients, is most eminently useful to such as are desirous of improvement in the art of decoration; and in order to furnish an example, we shall, in the present work, endeavour to construct our figures upon geometrical principles, drawing them from the purest classic models, selected from those precious remains of antiquity which were executed when the arts and sciences were in the very zenith of perfection.

Mere language alone is insufficient to convey an adequate idea of those images that are conceived in the mind of one person, to the understanding of another: for since we know that even such simple terms as a point or an angle cannot be strictly or accurately defined, it may be easily inferred, that our ideas of many forms and positions, though easily conceived, cannot be expressed intelligibly by words. From this acknowledged defect of written description, we are, therefore, compelled to have recourse to some sensible mode of representation, by which the analogy, positions, and connexions of the separate parts of a body, may be clearly exhibited to the eye.

Two distinct modes of representation have accordingly been invented, by which the forms, positions, and measures of the original parts of a complex object may be correctly ascertained. One is denominated Perspective, the other Orthographical Projection, and each possesses a peculiar advantage of its own.

By the aid of perspective drawing, viewed from a certain point, the object is exhibited to the eye in such a manner as to produce the same image, and the same effect on the imagination, as the real object itself, when viewed from a corresponding point.

By means of an orthographical projection,* although the object be not so agreeably represented to the eye, the exact measures of all its parts can be ascertained with incomparably less trouble than by perspective representations.

* Orthographic projection, as applied to the representations of the circles of the sphere, has been long understood; but general representations are only of modern date. The French method of projection, by means of co-ordinate planes and traces, is very ingenious, and is in general use among them; but a more commodious method, by means of an intersecting line, was first introduced into Rees' Cyclopædia by the author of this work, Mr. Peter Nicholson, in the year 1813. This gentleman has been successful in applying his method to many architectural solids, floors, roofs, &c. (see his Builder's Director.) Had Professor Farish been acquainted with these principles, he never would have given so imperfect a system, under the unmeaning name of Isometrical Perspective.—Ed.

A species of orthographical projection has been long understood and practised by Cabinet-makers, Carpenters, Joiners, Architects, and artisans concerned in Building, by means of plans, sections, and elevations.

A Plan is a representation of all the horizontal and other lines in the height of the surface of an object upon a horizontal plane, by means of lines, drawn perpendicularly from all, or a sufficient number of points in these lines, to the said horizontal plane. A Section is a projection on a vertical plane, (dividing the object into two parts,) and is formed by lines falling perpendicularly from all the points in the horizontal and other lines of the object on one side of the plane of projection, upon the said plane; shewing, at the same time, those parts of the object that are really cut, or that coincide with the plane of projection. Lastly, an Elevation is a projection, upon a vertical plane, placed before the object by lines falling perpendicularly from all the points in the horizontal or other lines in the surface of the object to the plane of projection. Hence, the projecting rays in a section, and in an elevation, are parallel to the horizon; and hence, also, when the lines of the object are parallel to the plane of projection, the lines of the projections are equal and similar to the corresponding lines of the object.

Plans and elevations are eminently useful, for the purpose of enabling workmen to comprehend the designs of rectangular objects, especially where the object is simple, and all the faces of the three planes of projection are parallel to one or other of the faces of the object. The different forms in the three planes being represented by equal and similar figures, furnish an easy method of finding the dimensions. Yet, how useful soever this mode of representation may be to a tradesman, it does not convey to others, who are unacquainted with this species of drawing, any idea of the design; nor is it, after considerable study, that even proficients in new designs can connect all the different parts in their imagination, such as they would be in the original object. In complex designs, many plans, sections, and elevations are required to explain them. Much labour and attention are therefore spared by an orthographical projection, which not only connects the several parts, but also gives their due proportions.

As the construction of works, as well as every kind of delineation, requires the aid of mathematical principles, we have commenced our treatise with Practical Geometry, confining ourselves to such problems as may be found necessary, either to direct the mechanical execution, or to represent the object intended to be shewn.

In these two different species of projection, the art of perspective enables us to explain our designs in the most natural and in the most agreeable manner, both to the eye and to the understanding of others, and a sufficient number of its rudiments is given and illustrated, by their application to the subjects included in this treatise.

In order, however, to proceed with the utmost certainty in explaining to workmen the forms and positions of all the parts of a complex object, which are intended to be executed in every part, agreeably to certain dimensions in feet and inches obtained from a scale; we have deemed it requisite, without referring to more than one drawing, to explain as many of the principles of orthographic projection as may be required by the designer to communicate, and by the workman to understand, the complete intention of the design.

After having explained the principles of representing objects, we shall next proceed to the construction of FURNITURE; in which, from certain given parts, the remaining parts are found. This is a branch of solid Geometry, the knowledge of which is indispensable. It is equally useful to the Cabinet-maker, the Carpenter, and the Joiner.

The three grand branches which this work is designed to embrace, are, CABINET-MAKING, UPHOLSTERING, and DECORATING. In these departments it is not intended to direct the Artist in his mere mechanical operations, for with these it is presumed he is already fully acquainted; but to place before him various scientific principles, that on all occasions may become his guide.

To the CABINET-MAKER will be presented certain specific and permanent rules, equally applicable to dimensions and proportions in all their variety. These in their result will invariably ensure order, harmony, symmetry, and beauty, from which the eye receives gratification, and communicates pleasure to the mind.

To the UPHOLSTERER such directions will be given as will imprint on his work the footsteps of elegance and taste; so that while fancy dictates new modes of embellishment, an imperishable grandeur may associate with all his performances.

The DECORATOR must always, in a certain degree, be exposed to the freaks of caprice, and the ever varying mutability of fashionable taste. With him, invention and genius are indispensable qualifications; and these, when combined, give perfection to his art. But, amidst this instability, there are certain principles, from which his lines, his curves, his festoons, his drapery,

his combinations, and his arrangements, must not depart. With these principles it is the design of the Author to furnish him.

The Plates which embellish this volume, being entirely from original inventions and drawings, will have a particular claim upon public attention; especially as they will be numerous, and executed in a superior style of elegance. But notwithstanding their originality, the explanations and references which accompany each, will render the whole perfectly intelligible; and their utility and advantage must be obvious to all who reflect upon their import and application.

To furnish the reader with every possible information on the subjects of which this volume treats, being the primary and anxious design of the Author, he flatters himself, that, from the principles developed, and the incalculable variety of designs to which they may be applied, it will be found a useful instructor, even should a different taste prevail.

Amidst the fluctuations of tasteful elegance, he will watch the kaleidoscope of fashion in all its movements, while this work is passing through the press, and avail himself of every appearance that may be deemed worthy of preservation.

But whatever changes the progress of time may introduce, of this truth he has an indubitable assurance, that although fashions are fickle and capricious, yet the scientific principles, upon which alone these fashions are built, are imperishable and eternal.

Peter Nicholson.

LONDON, May 1st, 1826

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THE

CABINET-MAKER, UPHOLSTERER,

AND

COMPLETE DECORATOR.

GEOMETRY.

GEOMETRY forming the basis on which our superstructure is to be raised, has the first claim on our attention. This exalted science appears to have been understood in some degree by the ancient Egyptians, as we are informed by Herodotus: and indeed, in a country like Egypt, subjected to the annual innundations of the river Nile, which destroyed all the landmarks either by the impetuosity of its waters, or by the deposition of mud or sand, a practical knowledge of Mensuration became necessary, in order to restore to the proprietors of the lands their proper portions, which had been blended into one undistinguishable surface. Hence, the word was originally limited to the science of Mensuration, for it is compounded of two Greek words, γη, *earth*, and μετρεω, *to measure;* which, together, literally signify, measuring of the earth. But the Geometry of the Greeks is the science which treats of the properties of magnitudes, considered either as Lines, Angles, Surfaces, or Solids.

It is to this latter people that we are indebted for the perfection of this sublime branch of knowledge, and " it is remarkable (says Professor Playfair) that the writings of Euclid, at the distance of two thousand years, continue to form the most approved introduction to the mathematical sciences."

Having thus given a brief sketch of the origin of Geometry, we shall now collect as many of its simple rules as will be useful to the CABINET-MAKER in the formation of working drawings, and shall therefore proceed to

PRACTICAL GEOMETRY.

Practical Geometry treats of the methods of drawing lines in all manner of directions, and of the description of figures according to certain simple properties enumerated in words called

DEFINITIONS.

Def. 1. Every material substance, in the language of Geometry, is termed a Solid.

Def. 2. The external appearance (or outward face) of a solid is called a Surface.

Def. 3. When a surface is divided, either in reality or in imagination, into two parts, the division is termed a Line.

Def. 4. When two lines cross one another, the intersection is termed a Point.

Surfaces are therefore merely the conceived divisions of a solid, lines are the divisions of a surface, and points are those of a line, into parts, but have no separate existence as substances. The lines and points of the diagrams of the practical Geometer are, however, real surfaces, because it is necessary that they should be visible; but these are treated in the science as if they were metaphysically correct.

Def. 5. If while a line revolves round its two extreme points, every intermediate point remains in the same place, or point of space, the line is called a Straight Line.

Cor. 1. Hence, one straight line cannot meet another straight line in more than one point, unless they coincide in every point.

Cor. 2. Hence, two straight lines cannot enclose a space.

Cor. 3. Hence, if the position of two points in a straight line be determined, the position of the whole line is determined, for only one straight line can pass through these points.

The definition of a straight line, in Euclid, as it is translated from the Greek text, is obscure; a straight line, or right line, is defined to be a line which lies *evenly* between its extreme points, the word "evenly" standing as much in need of an explanation, as the word straight or right, which it is intended to define. If the word *equally* had been used by the translator instead of "evenly," the sense would have been quite as agreeable to the original text, and, though not explicit, would seem to imply the very idea of a straight line as we have defined it; viz. "a straight line is that which lies equally between its extreme points," which means, that it is alike related on all sides of the surrounding space. Professor Playfair's definition is excellent, it is as follows: *If there be two lines which cannot coincide in two points without coinciding altogether, each of them is called a straight line.* The objection to this is, that we are under the necessity of having recourse to lines instead of a line. This might have been avoided by supposing a line to be divided into any two parts, then if these parts could not coincide in two points without coinciding altogether, the line is a straight line; but the idea of cutting the line into two segments is not altogether agreeable.

If there be any objection to the definition of a line which we have given, the same must apply to the definition of solids generated by revolving a plain figure about an axis, as a cone is generated by a right-angled triangle.

Def. 6. A line, in which, if any two points be taken, and if the intercepted portion, however small, be not straight, such a line is called a Curve.

Def. 7. A Mixed Line is that which is compounded of straight and curve lines.

Def. 8. Linear Extension is the distance between one point and another, along a straight line between them, and this is also called the Distance of the Points.

Def. 9. A Plane, or Plane Surface, is that which will every where coincide with a straight line.

It is a curious fact, however, that though a surface may admit of two straight lines being drawn in that surface through any point in it, yet the surface may not be a plane, but if the surface admits of three straight lines being drawn upon it through any point, the surface is necessarily a plane.

Two straight lines, which meet each other, are always in a plane.

Def. 10. An Angle is the opening or space contained between two lines which meet each other.

Def. 11. A Rectilinear Angle is that w ich is contained by two straight lines, which are not in the same straight line.

All angles henceforth expressed are supposed to be rectilinear, unless the contrary is stated.

Def. 12. The point where two straight lines, which form an angle, meet each other, is called the Vertex.

Def. 13. If in two angles, in which, if the one be applied upon the other, so that when their vertices and one of their containing lines coincide, the two remaining lines coincide also, these Angles are said to be Equal.

Hence the length of the lines, containing an angle, do not make the angle greater or less by being longer or shorter.

Def. 14. If two equal angles have a common line of separation, and the other two containing lines in the same straight line, each of these angles is called a Right Angle; likewise the common line is called a Perpendicular to the straight line formed of the other two.

Def. 15. If the contained space of an angle be applied upon that of a right angle, so that the two vertices and one of the containing lines of each may coincide, and the other containing line of the angle applied fall between the containing lines of the right angle, the angle thus applied is called an Acute Angle.

Hence an acute angle is less than a right angle; for the right angle contains the acute angle and another angle besides.

Def. 16. If the contained space of an angle be applied upon that of a right angle, so that the two vertices and one of the containing lines of each may coincide, while the other containing line of the angle applied falls without the space contained by the two lines of the right angle, the angle thus applied is called an Obtuse Angle.

Hence an obtuse angle is greater than a right angle; for the obtuse angle contains not only the right angle, but likewise another angle besides the right angle.

Def. 17. If two lines, in the same plane, are so situated that they cannot form an angle, however far they may be extended, these two lines are said to be Parallel.

Def. 18. A Figure is that which is bounded by one or more lines, called the sides or edges of the figure.

Def. 19. A Rectilineal Figure is that which is bounded by straight lines.

Here we shall observe, that all boundaries are supposed to be rectilineal, unless a curve is expressed.

Def. 20. A Triangle is a figure, consisting of three sides, and consequently, of three angles; because an angle is opposite to every side.

In respect to the Sides of a Triangle.

Def. 21. If a triangle has all its sides equal, it is called an Equilateral Triangle.

It is easy to prove, and it is almost self-evident, that the angles, as well as the sides of an equilateral triangle, are equal.

Def. 22. If a triangle have two of its sides equal, it is called an Isosceles Triangle.

Def. 23. If a triangle have no two of its sides equal, it is called a Scaline Triangle

In respect of the Angles of a Triangle.

Def. 24. If a triangle have one right angle, it is called a Right-angled Triangle.

Def. 25. If a triangle have one obtuse angle, it is called an Obtuse-angled Triangle.

Def. 26. If a triangle have its three angles acute, it is called an Acute-angled Triangle.

Def. 27. A four-sided figure is called a Quadrangle, Quadrilateral, or Trapezium.

Def. 28. If a four-sided figure have one pair of its sides parallel, it is called a Trapezoid.

Def. 29. If a four-sided figure have both pairs of its sides parallel, it is called a Parallelogram.

Def. 30. A parallelogram, of which neither the angles nor the sides are all equal, is called a Rhomboid.

Def. 31. A parallelogram, which has all its four sides equal, but not its angles, is called a Rhombus.

Def. 32. A parallelogram, which has one of its angles a right angle, is called a Rectangle.

It may be proved, and indeed it is in some measure evident, that all the angles of a parallelogram are equal, and that the opposite sides are equal.

Def. 32. A rectangle, which has not all its sides equal, is called an Oblong.

Def. 33. A rectangle, which has all its sides equal, is called a Square.

Def. 34. Every figure, which has more than four sides, is called a Polygon.

Def. 35. A polygon, which has all its sides equal, is said to be Equilateral.

Def. 36. A polygon, which has all its angles equal, is said to be Equiangular.

Def. 37. A polygon, which is both equilateral and equiangular, if such can be, is called a Regular Polygon.

There may be some objections to this definition, which is that usually given, for it is easy to conceive, that all the sides of a figure may be equal, but not that the angles are equal at the same time. This coincidence of the equality of sides and angles requires demonstration, therefore, in order to qualify it, we have inserted the words, *if such can be.*

Def. 38. A regular polygon, of three sides or angles, is called a Trigon.

A trigon is, therefore, the same as an equilateral triangle, for an equilateral triangle may be proved to have its angles as well as its sides equal.

Def. 39. A regular polygon of four sides, is called a Tetragon.

A tetragon is, therefore, the same as a square, for it may easily be proved, that all the angles of a square are equal, as well as the sides.

Def. 40. A polygon of five, six, seven, eight, nine, ten, eleven, twelve, &c. sides, is called a Pentagon, Hexagon, Heptagon, Octagon, Enneagon, Decagon, Hendecagon, Dodecagon, &c.

Def. 41. A Circle is a plane figure, contained by one line called the Circumference, and this line is every where equally distant from a point in the figure, called the Centre of the Circle.

Def. 42. The Radius of a Circle is any straight line drawn from the centre of the circle to its circumference.

Def. 43. The Diameter of a Circle is a straight line passing through the centre, and terminated at each extremity by the circumference.

Corol. Hence the diameter of a circle is equal to twice the radius.

Def. 44. A Chord is any straight line terminated at the two extremities by the circumference.

Def. 45. An Arc of a Circle is any part of the circumference.

Def. 46. A Segment of a Circle is a portion of a circle contained by an arc and a chord.

Def. 47. A Sector of a Circle is a portion of the area contained by two radii, and the arc intercepted between them.

PLATE I.

Problem I.

To bisect a given straight Line DE, Figure 2, *by a Perpendicular.*

From the points D and E, as centres, with any equal radii, describe the intersections *f* and *g*. Draw *fg*, intersecting DE in the point F, and F is the middle of the line DE; and the line *fg*, which passes through F, is at the same time perpendicular to DE.

Problem II.

From a given Point C, *in a given straight Line* AB, Figure 1, *to erect a Perpendicular.*

Mark the points c and *d* in the line AB, equally distant from C, and from each of the points c, *d*, with any equal radii, greater than *c*C or C*d*, describe the intersection D, and draw CD. CD is perpendicular to AB.

Problem III.

From a given Point g, Figure 3, *in a given straight Line* AB, *to draw a Perpendicular.*

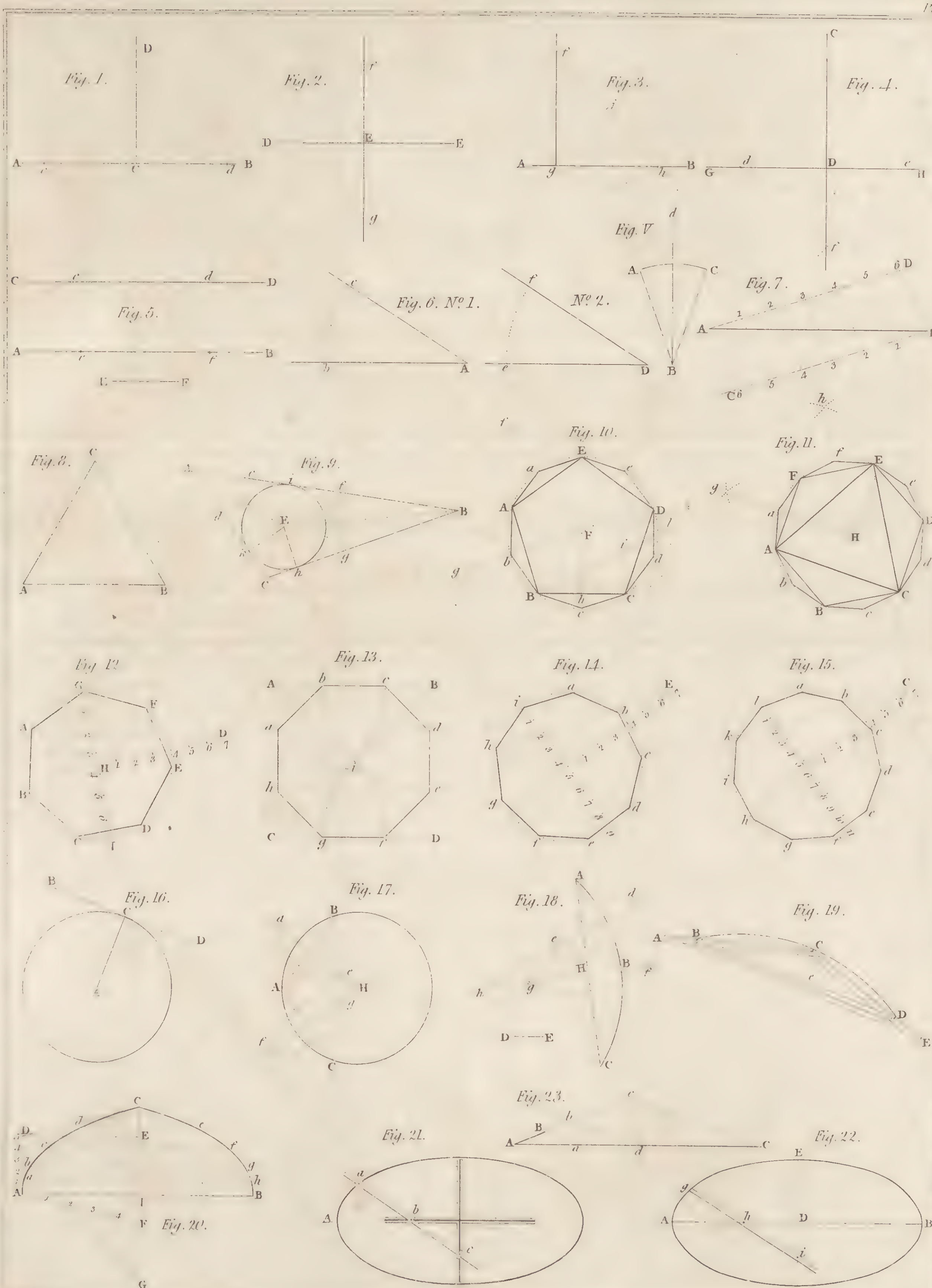
From some convenient point *i*, above the line AB, as a centre, and with the distance *ig*, describe an arc *fgh*, meeting AB in *h*. Join *hi*; produce *hi* to *f*, and draw *fg*, and *fg* is perpendicular to AB.

Problem IV.

From a given Point C, Figure 4, *to draw a Perpendicular to a given Line* GH.

From the point C, describe an arc *de*, so as to intersect GH in the points *d* and *e*. From each of the points *d* and *e*, as centres, with any equal radii greater than the half of *de*, describe arcs intersecting each other in *f*, and draw the line C*f*: C*f* is perpendicular to GH.

Practical Geometry.



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Problem V.

At a given Distance E F, Figure 5, *to draw a straight Line parallel to a given straight Line* A B.

From any two convenient points *e, f,* in the line A B, with the radius E F, describe arcs at *c* and *d,* and draw the straight Line C D to touch the arcs at C and *d.* C D is parallel to A B, as required.

Problem VI.

At a given A, Figure 6, No. 1, *in the straight Line* A *b, to make an Angle equal to a given* e D f, No. 2.

From the point D, with any convenient radius, describe an arc *ef,* and with the same radius, from the point A, describe the arc *bc.* Make the arc *bc* equal to *ef,* and draw A *c.* *b* A *c* is the angle required.

Problem VII.

To bisect a given Angle ABC, Figure V. *that is, to divide it into two equal Parts.*

Let C be any point in B C; make B A equal to BC; and from the points A and C, with any equal radii, describe two arcs so as to intersect in *d,* and draw the line *d* B. *d* B will divide the angle A B C into two equal angles. This is called bisecting the angle.

Problem VIII.

To divide a straight Line A B, Figure 7, *into any number of equal Parts.*

Draw any line A D, and through the point B draw B C parallel to A B. Run as many equal parts along the lines A D and B C, as the line A B is to contain equal parts. In this example it is required to divide the line A B into six equal parts. Join the point A to the last division C, and through the points 1, 2, 3, &c. in A D, draw lines parallel to A C, to intersect the line A B, and A B is divided, as required to be done.

Problem IX.

Upon a given straight Line A B, Figure 8, *to describe an Equilateral Triangle.*

From each of the points A and B, as centres, and with the radius A B, describe an intersection C on one side of the line. Join C A and C B, and A B C is the equilateral triangle required.

Problem X.

In a given Triangle A B C, Figure 9, *to inscribe a Circle.*

Bisect any two of the angles A and B. From the point E, where the bisecting lines meet, draw E *h* perpendicular to B C, on any one of the sides. From the centre E, with the radius E *h*, describe the circle *h i k*, and the circle *h i k* will touch the three sides of the triangle A B C, as required.

Problem XI.

Upon a given straight Line B C, Figure 10, *to describe a Pentagon.*

Bisect B C by the perpendicular *h* F. Draw C *i* parallel to *h* F, and make C *i* equal to C *h*. Join B *i*, and produce B *i* to *l*, making *i l* equal to *i* C. From the centre C, with the distance C *l*, cut the line *h* F in F. From F, as a centre, with the radius FB or FC, describe the circle A B C D E; repeat B C within the circumference, so that the extremities of every two adjacent chords may meet, and the lines thus drawn will divide the circumference into five equal parts.

If a pentagon be inscribed in a circle, it is very easy to inscribe a decagon, by bisecting the sides of the pentagon by perpendiculars, and joining the points where the perpendiculars cut the circumference to the extremities of the chords of the pentagon, as in the figure *a*A,*b*B,*c*C,*d*D,*e*E,*a*.

Problem XII.

In a given Circle, Figure 11, *to inscribe a Triangle, a Hexagon, or a Dodecagon.*

Apply the radius of a circle to the circumference as connected chords, and it will contain the radius six times, as A B, B C, C D, D E, E F, F A. Bisect

each of the Arcs in the points *a, b, c, d, e, f,* and join these points to the extremities of the chords of the hexagon, and a dodecagon will be obtained.

In this manner may the circle be divided into 24, 48, &c. parts, always doubling the number of sides.

GENERAL OBSERVATION.

Any regular polygon, inscribed in a circle, being once obtained, we may double the number of sides, and double this last number again, and so on, as often as we please; and thus, if we have a triangle inscribed in a circle, we may have the series of polygons, having 3, 6, 12, 24, 48, &c. sides. If we have a pentagon inscribed in a circle, we may have the following series of Polygons, having 5, 10, 20, 40, &c. sides. If we have an octagon inscribed in a circle, we may have the series of polygons, having 4, 8, 16, 32, &c. sides; and thus we have direct rules for dividing a circle into 3, 4, 5, 6 equal parts, or any polygon, of which the number of sides is expressed by any term of a geometrical progression, of which the [first term is 3, 4, 5, or 6, and the common multiplier 2. Rules for other polygons are neither easy to be described in words, nor to be given in figures of construction.

PROBLEM XIII.

In a given Circle to inscribe any regular Polygon.

Figures 12, 14, 15.

Draw the diameter, and divide it into as many equal parts as the polygon is to have sides. Bisect the diameter by a perpendicular, cutting the opposite sides of the circumference. Produce the perpendicular, so that the part without the circle may be three-fourths of the radius. From the extreme point of the part produced, draw a straight line through the second point of division in the diameter to meet the circumference. Join the intersected point in the circumference to the extremity of the diameter, whence the equal parts commence, and the line thus joined will be a

chord of the circumference in which it may be contained, as often as required, very nearly.

Thus, in Figure 12, the intention is to inscribe in a circle a polygon of seven sides. The diameter G I is divided into seven equal parts. The perpendicular H D is drawn from the centre H, and the radius is divided into four parts, and three are set without the circle from four to seven. A line is drawn from D through the second point 2 in the diameter G I, to meet the circumference in A, and the line A G is the side of a polygon of seven sides; and by inspecting Figures 14 and 15, it will be seen that the same principle extends in all cases.

Figure 12 is a heptagon; Figure 14 an enneagon; and Figure 15 an hendecagon. These methods are, however, only near approximations.

Problem XIV.

In a given Square A B C D, Figure 13, *to cut out the largest regular Octagon.*

Draw the diagonals A D and C D, intersecting each other at *i*. From the points A, B, C, D, as centres, with the radius A *i*, equal to half one of the diagonals, cut the sides of the square in the points *a, b, c, d, e, f, g, h*. Join *ab, cd, ef, gh*, and *abcdefgh* is the octagon required.

Problem XV.

To draw a Tangent to a given point C, Figure 16, *in the Circumference of a Circle, of which the Centre is* A.

Join A C. Through the point C draw B D perpendicular to A C, and B D is the tangent required.

Problem XVI.

Through three given Points B, A, C, Figure 17, *not in a straight line, to draw the Circumference of a Circle.*

Join the two points B and C to the middle point A. Bisect each of the lines A B, A C, by perpendiculars meeting in H. From the point H, as a

centre with the radius BH, AH, or CH, describe a circle BAC, and the circumference will pass through the three points B, A, C, as required.

Problem XVII.

To describe the Arc of the Segment of a Circle, of which the Chord is AC, Figure 17, *and the Rise of the Arc the Line* DE.

Bisect the chord AC by a perpendicular *hf*, intersecting AC in the point H. Make HB equal to DE. Join AB, and bisect AB by a perpendicular *hd*. From the point *h*, where the two perpendiculars meet as a centre, with the distance *h*B, describe the arc ABC, which is that required.

Another Method, Figure 19.

Having set off the perpendicular from the middle of the chord to the point C in the circumference; fasten two laths, AE, EC, together, so as to intersect at C, and the edges to be on the points B and D. Brace these laths together by a cross-piece BD, so that the angle BCD may be immoveable. Bring the point C to B, and move the apparatus round, so that the leg AC may run upon the point or pin at B, and the leg CE upon the point or pin at D; then a pencil held at C, in the act of moving, will describe the curve required.

This method may be used where the radius would extend beyond the space upon which the operation is required to be performed.

Problem XVIII.

To describe a Gothic Arch to any Width, AB, Figure 20, *and Perpendicular Height* IC *in the middle of* AB, *so that the two Sides may meet in any given Angle in the Point* C.

Produce CI to G. Make the angle GCD equal to half of the vertical angle. Draw AD parallel to IC. In GC make GF equal to AD, and join AF. Divide AF and AD each into the same number of equal parts, at the points 1, 2, 3, &c. From G, through the points 1, 2, 3, &c. in AF, draw lines to

intersect lines drawn from C to the corresponding points 1, 2, 3, &c. in A D, in the points *a*, *b*, *c*, *d*. Put pins in the points A, *a*, *b*, *c*, *d*, C, and bend a slip of wood round them, and draw a curve by the edge which touches the pins, and this curve will form one side of the Gothic Arch.

In the same manner we may describe the other side. But when one side of a symmetrical figure is obtained by any method, the other side will be found by the following process.

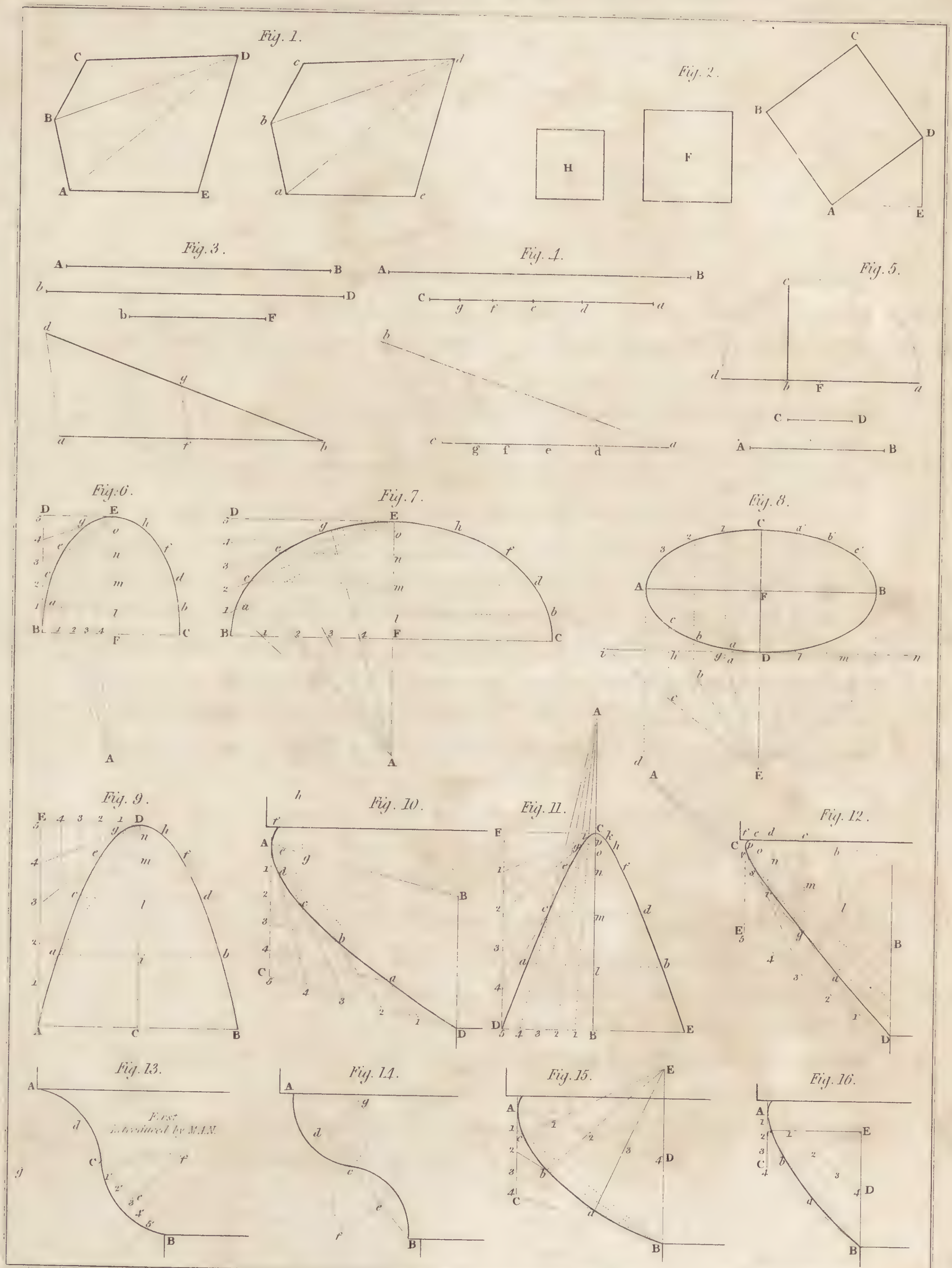
From the points *a*, *b*, *c*, *d*, draw lines parallel to A B, to terminate on the other side of C G, as double ordinates. From the points of intersection in I C, transfer the ordinates on the left of I G to the right hand side of it, and they will reach to *h*, *g*, *f*, *e*. Put in nails as before in the points B, *h*, *g*, *f*, *e*, C, and bend the slip of wood to touch all the pins, and draw the curve as before.

Problem XIX.

To describe an Ellipse, to any Length and Breadth, by means of the Instrument called a Trammel, an Instrument well known to Workmen. Figure 21.

Let three pins, *a*, *b*, *c*, in a straight line, be fixed to three cross-pieces through which the rod passes; suppose one of the pieces which contains the pin C, to be fixed to the rod, and the pieces *a* and *b*, in which the other two pins are fixed, to be moveable, and the nearest point to the fixed point being of steel, and the other to be a pencil.

Move the nearest sliding pin from the fixed pin, so that their distance may be equal to half the breadth of the ellipse, and move the pencil point from the fixed pin, so that their distance may be equal to half the length, or to half the longer axis. Place the arms of the trammel so that the grooves may coincide with the axis, the fixed point C of the rod in the groove which coincides with the conjugate axis, and the middle point in the groove over the transverse axis: then move the rod round from the extremity A of the longer axis, and the pencil at *a* will describe the curve.



Nicholson del. *sc.*

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Figure 22, shews how points may be found in the curve upon the same principle.

Let *g h i* be a slip of pasteboard, or a piece of ivory, straight on the edge *g h i*. Mark the three points *i*, *h*, *g* on the straight edge, so that *i h* may be equal to the semi-axis minor, and *i g* equal to the semi-axis major. Place the point *i* in the axis minor, and the point *h* in the axis major, and mark the point *g* upon the board or paper, which will give one point in the curve Repeat this operation till a sufficient number of points are found; stick in pins or nails in all the points, bind a pliable slip of wood so as to coincide with all the pins or nails, and draw a curve by the edge of the slip which touches the pins, and it will be the ellipse required.

If the points are found on paper, the curve may be drawn through the points with sufficient accuracy by hand.

Problem XX.

To find any number of continued Proportionals, or to divide a given Line A C *into a Series of continued Proportionals, the first* c d *being given.*

Draw a line A *c*, making any angle C A *c*, with A C. In A *c*, cut off A *c* equal to A *d*, and join C *c*. Draw *d b* parallel to C *c*, meeting *a c* in *b*. From A C cut off A *a* equal to A *b*, and draw *a* B parallel to *db*, and proceed in this manner, and the line will be divided as required to be done.

PLATE II.

Problem XXI.

Upon a given straight Line to form a Polygon, similar to a given Polygon ABCDE, *Figure* 1.

Make the straight line *ae* equal to A E. Find the point *d* by describing arcs with the radii A D, E D, from the centres *a*,*e*; find the point *b*, by

describing arcs with the radii A B, D B, from the centres *a,d,c,* and find the point *c,* by describing arcs with the radii B C, D C, from the centres *b* and *d.* Join *ab, bc, cd, de,* and *abcde* will be the polygon required.

Problem XXII.

To make a Square equal to the Sum of two given Squares, H, F. Figure 2.

Draw the straight line A E and E D perpendicular to A E. Make A E equal to the side of the square F, and E D equal to the side of the square H. Join A D. Draw A B perpendicular to A D, and make A B equal to A D. Find the point C, by describing arcs from B and D, with a radius, each equal to A D. Join B C, and C D; then A B C D is the square required.

Problem XXIII.

Given three straight Lines A B, *b* D, *b* F, *to find a fourth Proportional.*

Draw the two straight lines *ba, bd,* making any convenient angle with each other. Make *bd* equal to A B, *bd* equal to *b* D, cut *ba* in *f,* so that *bf* may be equal to *b* F. Join *ad.* Cut *bd* in *g*, by drawing *fg* parallel to *ad,* an' *bg* is the fourth proportional required.

Problem XXIV.

To divide a given straight Line A B, Figure 4, *in the same Proportion as another* C a *is divided.*

Draw the two straight lines *ac, ab,* making any convenient angle with each other. Make *ac* equal to *a* C, *a b* equal to A B, and join *bc.* Cut the straight line *a c* in the points *d, e, f, g,* so that *ad, ae, af, ag* be equal to the parts *ad, ae, af, ag* of the given line *a* C. Cut the line *ab* by drawing lines through the points *d, e, f, g* in *a c,* parallel to *cb,* and *ab* will be divided in the same proportion as *ac.*

Problem XXV.

Two straight Lines AB, CD, Figure 5, *being given, to find a mean Proportional.*

In the straight line *da* make *db*, *ba*, respectively equal to the lines CD, AB. On *da*, as a diameter, describe the semicircle *dca*. Draw *bc* perpendicular to *da*, and *bc* is the mean proportional required.

Problem XXVI.

To describe an Elliptic Arch, by finding Points in the Curvature to any Width BC, *and Height* FE, Figures 6 *and* 7.

Find the point A in EF, produced by making FA equal to FE. Divide BF and BD each into the same number (5) of equal parts. Find the points *a*, *c*, *e*, *g*, by drawing lines from the points 1, 2, 3, &c. in BD *b*E, to meet the corresponding lines drawn from A through the points 1, 2, 3, &c. in BF. Through the points B, *a*, *c*, *e*, *g*, E, draw a curve by the edge of a lath or slip of wood. The other half may be found in the same manner, or by transferring them upon the double ordinate.

Another Method of finding Points in the Curve of an Ellipse is that exhibited in Figure 8.

Let AB and CD be the two axes given in position and magnitude. Draw *in* parallel to the greater axis. Find the points *a*, *b*, *c* in the curve, thus draw lines *aa'*, *bb'*, *cc'*, &c. through the centre F. Cut the line IN in *a*, *b*, *c*, &c. by producing F*a*, F*b*, F*c*, &c. Find the point E, by producing FD, and making DE equal to FA or FB. From E, with the radius ED, describe an arc. Find the points *a*, *b*, *c* in the arc, by joining *g*E, *h*E, *i*E. Draw *aa*, *bb*, *cc*, and through the points D, *a*, *b*, *c*, A draw a curve. Make F*a'*, F*b'*, F*c* respectively equal to F*a*, F*b*, F*c*, &c.

PROBLEM XXVII.

To describe a Parabola, Figure 9, *by finding Points* a, c, e, g *in the curve.*

Let A B be the base or double ordinate, and C D the height or abscissa.

Draw A E and D E parallel to C D and A B. Divide A E and D E each into (5) the same number of equal parts. Find the points *a, c, e, g,* by drawing lines from 1, 2, 3, &c. in A E to D, to intersect lines drawn parallel to C D through 1, 2, 3, &c. in D E. Draw the curve A *a c e g* D through the points, and the other side by transferring the ordinates to those on the other side of the abscissa.

PROBLEM XXVIII.

To draw the Section of an Ovolo Moulding in the Form of a Parabolic Curve A, Figure 10 *being the Point of Projection, and* D *the Point where the End and Upper Edge of the Fillet below meet each other.*

Draw A C perpendicular to the length of the moulding, and draw D C at pleasure, depending on the form of the moulding.

Divide A C and D C each into the same number of equal parts (5). Find the points *a, b, c,* &c. by drawing lines through the points 1, 2, 3, &c. in D C to the point A, to intersect lines drawn parallel to C D through the points 1, 2, 3, &c. in A C, and draw the curve D *a b c d* A *f.*

PROBLEM XXIX.

To describe an Hyperbola, having an Ordinate B D, Figure 11, *and the Abscissa* B C.

Draw D F and C F parallel to B C and B D. Produce B C to A. Take the point A at a greater or less distance from C, as the curve is required to be flatter or quicker at the point C. Divide B D and F D each into the same number of equal parts (5). Draw lines from 1, 2, 3, &c. in B D to A, to intersect lines drawn through 1, 2, 3, &c. in E D to C. Draw a curve through D and through the points *a, c, e, g* of intersection, and it will be one-half of the curve required.

Figure 12, exhibits the application of the hyperbolic curve, in drawing the section of a moulding, B D being the ordinate, D C the abscissa, and the point D being the upper edge of the fillet at its projection.

PROBLEM XXX.

To describe the Section of a Cima-recta or Ogee Moulding, A, Figure 13, *being the Top of the Section, and* B *the Bottom.*

Join A B, and divide A B into two equal parts at the point C. Divide C B into six equal parts, and divide B C, C A, each by a perpendicular *cf* and *gd*. Cut the line *cf* by an arc described from B, with the radius of five equal parts. Make *dg* equal to *cf*. From the point *f*, with the radius *f* B, describe the arc B C, and from the point *g*, with the radius *g* C, describe the arc C A, and B C A will be the moulding required

PROBLEM XXXI.

To describe a Semi-reversa or Ogee Reverse, Figure 14, *the Points* A *and* B *being the Ends of the Section of the Moulding.*

Divide A B into two equal parts in *c*, and bisect B *c*, *c* A, each by the perpendiculars *cf*, *dg*. From the middle points *e* and *d* make *ef* and *dg*, each equal to B *e* or *ec*. From *f*, with the radius *f* B, describe the arc B *c*, and from *g*, with the radius *gc*, describe the arc *c* A; then B *c* A is the semi-reversa required.

Fi.ures 15 and 16, shew the application of the method of describing an ellipse, by points to an ovolo moulding, D B and D A being semi-conjugate diameters, from which the curve may be described, similar to figures 6 and 7, from the axis.

PLATE III.

Problem XXXII.

To Draw the Section of a Cima-recta, having the Projecture of its Extremities at a *and* d. Figure 1.

Produce the upper edge of the lower fillet from *a* to *c*. Draw *dc* and *ab* perpendicular to *ac*. Bisect *bd* in *f*, and draw *fg* parallel to *ab*; then *fg* will bisect *ac* as well as *bd*. Bisect *fg*, and through the point of bisection draw the straight line 4-4, meeting *ab* in 4, and *dc* in 4. Divide the distance between the point of bisection and each point at 4, into any number of equal parts, for example into 4, and mark the points of division 1, 2, 3; also, divide the distance between the point of bisection, and each of the points *f* and *g*, into the same number of equal parts, viz. four. From the points *a, b, d, c,* draw lines through the points of division 1, 2, 3, each line to intersect as in the figure, and through the points of intersection draw a curve, and the curve will be the cima-recta required.

In the cima-reversa, figure A, the point *a* is given as the point of greatest projecture, and the sloping direction *fb*, in the middle of the moulding, is given in position; *acdb* and *dfgh* are parallelograms, in which *cd* and *dh* are equal; also *db* and *df* are equal to each other. Produce *dh* to *m*, and make *hm* equal to *hd*. Produce *dc* to *e*, and make *ce* equal to *cd*. Divide *hg*, *gf*, also *ab*, *ac*, each into the same number of parts; then proceed to find the points of intersection, and draw the curve as before.

Problem XXXIII.

To describe a Semiovolar Curve, compounded of Circular Arcs, so as to represent the Section of a Semi-Elliptic Arch to any Length and Height.

METHOD FIRST—FIGURE 2.

Let AB be the length or greater axis. Bisect AB in F, by the perpendicular CR, and make FC and FR each equal to the height of the arch. Draw AN

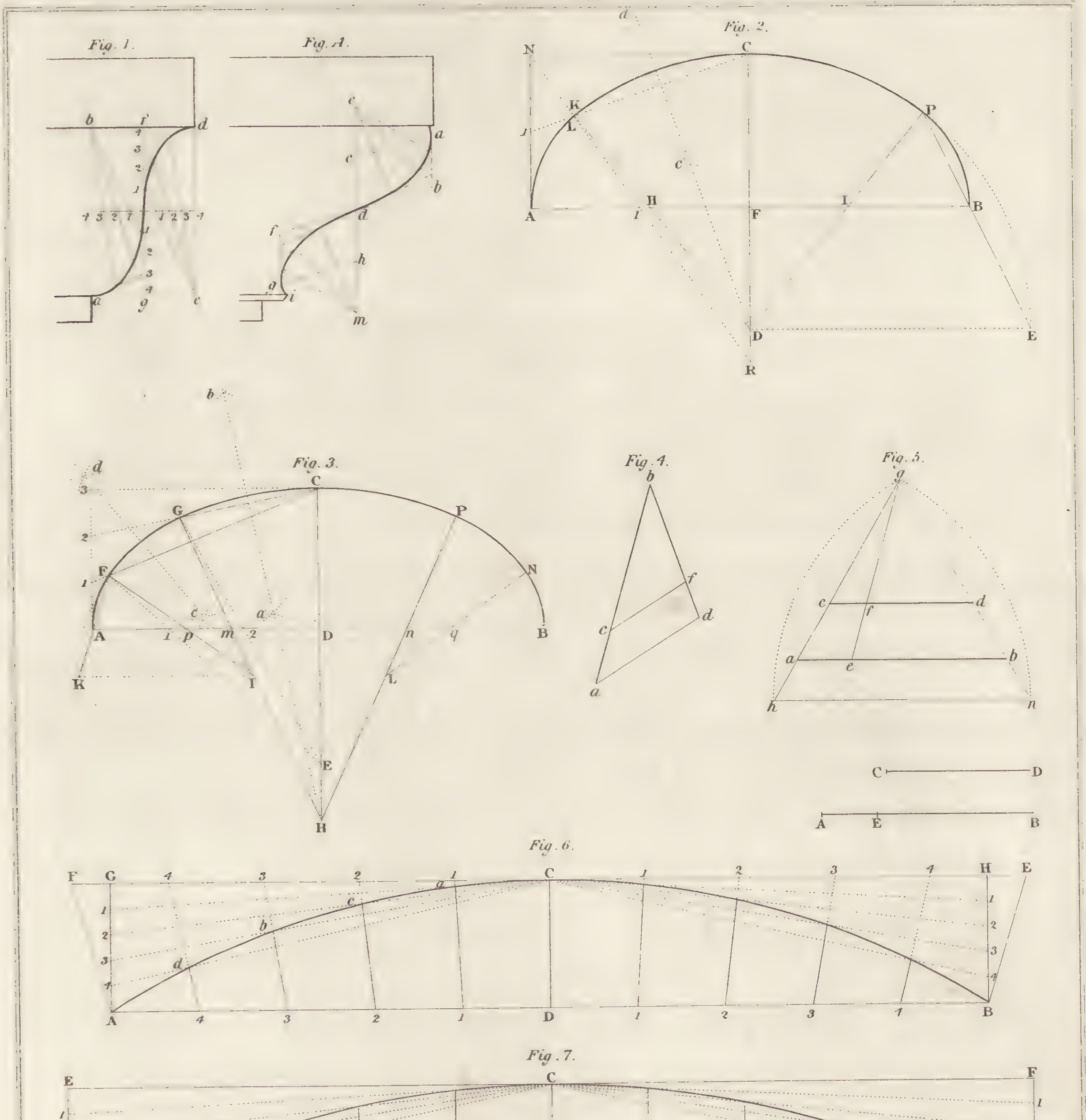


Fig. 1.
Fig. A.
Fig. 2.
Fig. 3.
Fig. 4.
Fig. 5.
Fig. 6.
Fig. 7.
Fig. 8.

parallel to C R, and C N parallel to A B. Bisect the line A N in the point 1, and draw the lines 1C and R N, intersecting each other in the point L. Bisect C L by the perpendicular D*d*, meeting C R in D. Draw D E parallel to A B. From the point D, as a centre with the radius D C, describe the arc K C P E. Join E B, and produce E B to meet the circular arc C P E in P. Join P D, intersecting F B in I. Make F H equal to F I, and join D H, which produce to K.

From the point H, with the radius H K, describe the arc K A, and from the point I, with the radius I P, describe the arc P B. Then the compound curve A K C P B will resemble the section of an elliptic arch as required.

METHOD SECOND, STILL NEARER—FIGURE 3.

Let A B be the length or greater axis. Bisect A B in D, by the perpendicular C E. Make D C and D E, each equal to the height as before. Draw A 3 parallel to D C, and C 3 parallel to B A. Divide A D and A 3, each into three equal parts. From E, through the points 1, 2, in A D, draw the lines E F, E G, and from C through the points 1, 2, in A 3, draw the lines C G, C F. Produce C E to H. Bisect G C by the perpendicular *b* H, and draw the straight line G H, intersecting A B in *m*. In D B make D N equal to B*m*, and from H, through *n*, draw H P. Bisect F G by the perpendicular *d*I, meeting G H in I. Draw I K parallel to A B. From I, with the radius I F, describe the arc F K. Produce K A joined to F; join F I, intersecting D A in *p*. In D B make D*q* equal to D*p*. Produce L*q* joined to N. From H, with the radius H C, describe the arc G C P. From I, with the radius I G, describe the arc G F. From L, with the radius L P, describe the arc P N. From *p*, with the radius *p* F, describe the arc F A; and lastly, from *q*, with the radius *q* N, describe the arc N B.

Problem XXXIV.

Given three straight Lines, to find a fourth Proportional. Figure 4.

Draw any angle ***abd***. In ***ba*** make ***ba*** equal to the first of the given lines, and ***bc*** equal to the second. In ***bd*** make ***bf*** equal to the third line. Join ***cf***, and draw ***ad*** parallel to ***cf***, then ***bd*** is the fourth proportional.

Problem XXXV.

Given two straight Lines, and one of them divided into any number of Parts, to divide the other into the same number of Parts, and in the same ratio as those of the divided Line. Figure 5.

Let A B be the divided line, and C D the undivided line, and let E be a point of division in A B; also, let *hgn* be an equilateral triangle. From one of the vertices *g*, and upon the adjacent sides, make *ga* and *gb* equal to the divided line A B, and draw *ab*, then *ab* will be equal to the divided line A B. In *ab* make *ae* equal to A E, and join *eg*. Again, from the vertex *g*, and upon the adjacent sides, apply the undivided line C D, and draw *cd*, intersecting *eg* in *f*; then *cd*, equal to C D, will be divided in *f* in the same ratio which A B is divided in E.

SCHOLIUM.

It very frequently happens that segments, which have chords of very great extent, but which have a very small height, are required by the Cabinet-maker. It would be very inconvenient in such cases to find a rod of sufficient length to describe the arc, and in others altogether impossible, since the length of the radius would exceed any limited space. It will, therefore, be useful to shew how flat arcs may be described by means of a sufficient number of points being found in the curve, so that it may be drawn by the vertical face of a pliable slip of wood bent round pins placed in the points.

We may observe, that, in such cases it is of very little consequence whether the arc be that of a real circle, or that of any other curve, since all curves approach to the arc of a circle near the vertex. Therefore since an error cannot be made visible to the eye by using any curve indifferently, the easiest method must be preferred. The following Problems may be considered as various modes of effecting the object thus circumstanced.

PROBLEM XXXVI.

To describe the Segment of a Circle by means of Points, having the Chord and the height of the Arc given. Figure 6.

Let A B be the chord. Bisect A B by a perpendicular meeting A B in D. Make D C equal to the height of the segment. Draw F E parallel to A B. Join C A and C B. Draw A F perpendicular to C A, and B E to C B. Also, perpendicular to A B, draw A G and B H, meeting F E in the points G and H. Divide F C, C E, D A, D B, A G, B H, each into the same number of equal parts, for example, each into four. Join the corresponding points of division in the lines A B and F E. Draw lines from the points 1, 2, 3, in G A to C, intersecting the corresponding lines drawn from the points in F E to those in A B, in the points *a*, *b*, *c*, *d*, proceed with the other side in the same manner; then fixing pins or nails in the points, draw the curve A C B by means of a slip bent round the points, and the curve thus drawn will be the true arc of a circle.

PROBLEM XXXVII.

To describe the Curve of a Parabola, having a double Ordinate and the Abscissa given. Figure 7.

METHOD FIRST—BY POINTS.

Let A B be the length or double ordinate. Bisect A B by a perpendicular C D, meeting A B in D. Divide D A, D B, each into the same number of equal parts, viz. four. Draw E E parallel to A B; also draw A E and B F perpendicular to A B. Through the points 1, 2, 3, in D A and D B, draw as many lines perpendicular to A B. Divide A E and B F into the same number of equal parts, viz. four. Through the points 1, 2, 3, in A E and in B F, draw lines to C, intersecting the perpendiculars, then draw the curve as before.

METHOD SECOND—BY TANGENTS.

Let A B be the chord, and D E the height in the middle of A B. Produce D E to C, and make E C equal to E D. Join C A, C B. Divide A C and C B, each into the same number of equal parts, and in the same order. Lines being drawn through the corresponding points of division will form the curve required.

ORTHOGRAPHICAL PROJECTION.

The most useful methods of representing objects, depend upon the principles of Orthographical Representation, which, as before observed, enables the designer of Cabinet Furniture to exhibit a representation of the object which he conceives; to shew how the different parts will be connected together; and to foresee their just effect on the eye. By its means the workman comprehends the design intended; as it furnishes him with the angles of position and proportion of the parts, and thus enables him to bring it into actual existence, by forming, joining, and fixing the parts immoveably together.

Definitions.

1. Orthographical projection, is a method of representing objects on a plane, by lines corresponding to those of the object itself, in such a manner, that a straight line drawn from any point of a line in the object to meet the plane perpendicularly, will fall in the corresponding line of representation; and reciprocally, a straight line drawn perpendicular to the plane from any point of a line, will fall upon the line it represents in the original object.

Corol. Hence a perpendicular drawn from the extremity of a line of the object to the plane of projection, will fall in the corresponding extremity of the projection of that line.

2. The plane, on which the representation is made, is called the Plane of Projection, and the representation is called the Projection, as well as the Representation.

The straight lines, drawn from corresponding lines of the object and of the plane of projection, are called the Projecting Rays.

3. When the projection is made on a horizontal plane, it is called a Plan; when on a vertical plane, not cutting the object, it is called an Elevation; and when it cuts the object, it is called a Section.

4. A primitive or original plane, is a plane belonging to the object itself; any line or point in such a plane, is called a primitive line or point, in contradistinction to its representation, which is also called the projection of that line or point.

Though it would not be consistent with a practical treatise to enter into any detail of the theory, yet for the use of the designer and workman, it will be proper to enumerate such principles as will be easily understood, which being fixed in the mind, will greatly facilitate the practice of delineation.

Propositions.

1. Every primitive straight line is projected into a straight line.

2. Every primitive straight line, parallel to the plane of projection, is projected into an equal straight line.

3. Any primitive straight line, not parallel to the plane of projection, is to its projection as radius is to the cosine of inclination.

4. The parts of a divided primitive straight line, have the same ratio among themselves, as the parts of the projected line have among themselves.

5. Any curve line in a plane, parallel to the plane of projection, is projected into an equal and similar line.

6. Any figure in a plane, parallel to the plane of projection, is projected into an equal and similar figure.

7. A straight line, perpendicular to the plane of projection, is projected into a point.

8. An angle in a plane, parallel to the plane of projection, is projected into an equal angle.

9. The area of any plane figure is to the area of its projection, as radius is to the cosine of inclination of the plane.

10. The projection of a circle is an ellipse, of which axis major is to the axis minor, as radius to the cosine of inclination of the plane of the circle to the plane of projection.

Hence the axis major is equal to the diameter of the original circle, and it is parallel to the intersecting lines of the two planes.

A primitive object is a point, line, or plane figure, of which the projection is required.

In order to have a comprehensive idea of orthographical projection, we must first shew the projections of a point, and of lines and figures situated in a plane, and as the intersecting line is the only line that fixes the position of the object to the projection, and its projection must always be given* when the primitive object is given to find its projection.

In Plate IV. the intersecting line is understood to be given, as well as the angle of inclination of the primitive plane, and the plane of projection; therefore as these are constant in the data, it will not be necessary to enumerate them, but merely to suppose, that their being given is understood. In the six diagrams of this plate, the intersecting line is denoted by I I. Hence, when it is said, "Given the position of a point, or of a line," it must be understood, that the position of such a point or line is as it regards the intersecting line; and when the position of a plane figure is said to be "given," the meaning is, that the angle which one of the sides, or of some principal line, makes with the intersecting line, is given.

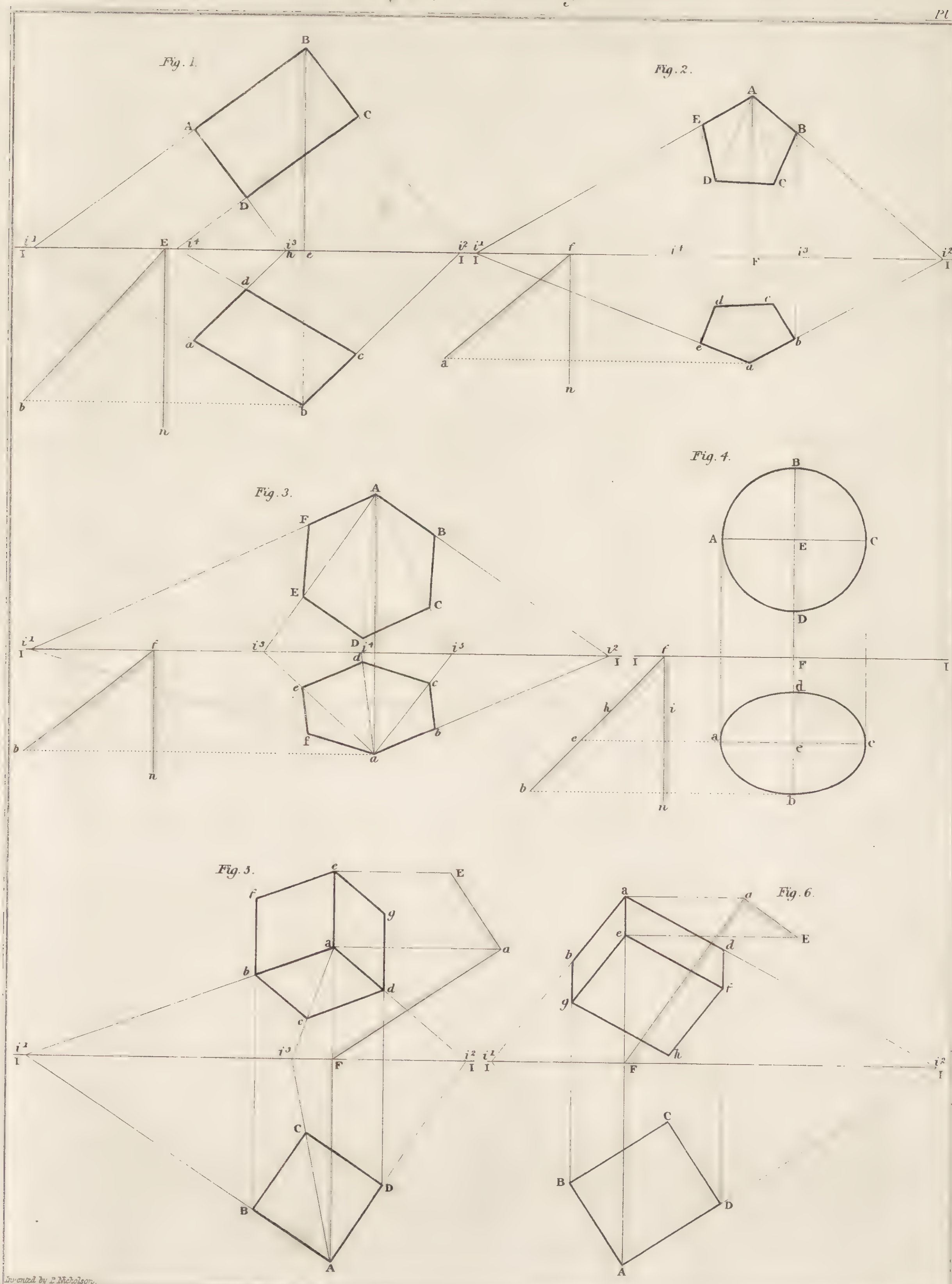
It is evident, that the projection of a point is in a straight line drawn through the point perpendicular to the intersecting line; for suppose that the primitive plane revolves round the intersecting line as an axis, the point will describe the circumference of a circle in a plane, perpendicular to the intersecting line; hence, the intersection of the plane of the circle with the plane of projection will be perpendicular to the intersecting line.

The seat of a point is the foot of the projecting ray of that point, viz. the point where the projecting ray meets the plane of projection.

* The Author of this treatise was the first person in this country who introduced the science of orthographical projection in general, and that by means of an intersecting line. He first discovered the principle in 1796, and prosecuted this method with unremitted vigour, as was well known to that able and ingenious engraver, Mr. Wilson Lowry, who recommended him shortly after to Longman and Co. to write the article "Projection" for Rees' Cyclopædia, which was published in the year 1813, see plates 1 and 2.

Orthographical Projection.

Pl. 4.



Invented by P. Nicholson.

Nicholson del.

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Angle of projection, of a plane figure, is the angle of inclination of the primitive plane and the plane of projection.

The straight line, which is drawn through a primitive point, perpendicular to the intersecting line, is called the perpendicular locus of that point.

A straight line in the plane of projection, parallel to the intersecting line, which contains the seat of a point, is called the parallel locus of that point.

In order to preserve perspicuity in referring to the following diagrams, when the primitive object is given in position and magnitude, to find the projection; for the sake of conveniency, the primitive plan is supposed to be one side of the intersecting line, and in the same plane with the plane of projection, which is situate on the other side. Hence, the angle of inclination of the primitive plane, and the plane of projection, must be supposed to be acute. By this means the confusion of lines is avoided, which must necessarily happen when the plane of projection is covered by the primitive plane, and the object and its representation are completely separated.

When the separation of delineation is completed, the primitive object is obliterated, being supposed to be drawn with pencil.

The shortest distances of a primitive point, and its projection, are to each other, respectively, as radius is to the cosine of the angle of projection.

PLATE IV.

Problem I.

To find the Projection of a Point B.

Draw B*b*, Figure 1, perpendicular to the intersecting line II, crossing II at *e*. At any point E, in II, draw E*n* perpendicular to II. Make the angle *n*E*b* equal to the angle of the inclination of the planes. Make E*b* equal to *e*B. Draw *b*b parallel to II, and the point b is the projection of the point B.

Problem II.

Two primitive Points, A *and* B, *being given, and the Projection a of one of the Points, to find the Projection of the other.*

Draw a straight line A*c*, to meet the intersecting line I I in *c*, at oblique angles. Join *a c*. Draw B*d* parallel to I I, meeting A*c* in *d*. Draw *de* perpendicular to I I, meeting *ac* in *e*. Lastly, draw *eb* parallel, and B *b* perpendicular to I I, and the point *b* is the projection of the primitive point B.

N. B. This Problem is given as an exercise to construct the diagram, by assuming an intersecting line, and two primitive points A and B; hence the figure is not exhibited in the Plate.

By this Problem we may find the projection of as many points as we please, having the projection of one of them given, without having the angle of the inclination of the planes. And thus the projection of any curve line may be found.

Problem III.

To find the Projection of a Rectilineal Angle.

Let A B C be a rectilineal angle. Produce the sides B A, B C, to meet the intersecting line I I in the points i^1, i^2. Find the projection b, of the point B, by Problem 1. Draw the straight lines bi^1, bi^2, and i^1bi^2 will be the projection of the angle required.

Problem IV.

Given the Projection of one Extremity of a Line, to find the unlimited Projection of the Line.

Case 1. When the primitive line is perpendicular to the intersecting line.

Draw a line through the given point, perpendicular to the intersecting line, and the line thus drawn is the unlimited projection required.

Case 2. When the primitive is parallel to the intersecting line.

Draw a straight line through the projection of the given extremity, parallel to the intersecting line, and the line thus drawn is the unlimited projection required.

Case 3. When the primitive line is inclined to the intersecting line in a given angle.

Produce the primitive line at the other extremity, of which the projection is not found, to meet the intersecting line. Join the point thus found to the projection of the extremity given, and the line thus joined will be the unlimited projection required.

Problem V.

Given the Projection of one Extremity of a Line, and the unlimited Projection of the Line, to find the Determinate Length of the Projection of that Line.

Through the extremity of the primitive, of which its projection is not found, draw a line perpendicular to the intersecting line to meet the unlimited projection of the line, and the line comprehended between the two points, of which the one is now found, and the other given, is the projection of the line required.

But if the unlimited projection of the line be perpendicular to the intersecting line, and if the projection of one extremity be given, the projection of the other extremity will be found thus. Draw two lines parallel to each other, through each extremity of the primitive line, to meet the intersecting line at oblique angles. Join the intersecting point of the line that passes through the extremity of which the projection is given. Through the other intersecting point draw a line parallel to the line joining the first intersecting point, and the given point of projection, to meet the perpendicular, and the part of the perpendicular comprised between this point and the given point of projection, will be the projection of the line required.

Problem VI.

To find the Projection of a Parallelogram.

Find the projection of one of its angles. Produce each of the other two opposite sides of the figure to be projected to meet the intersecting line. Draw lines from each of these two points in the intersecting line, parallel to the lines which contain the projected angle, to meet each of these lines, and the parallelogram, formed in the plane of projection, will be the projection of the parallelogram required.

Example.—Let it be required to find the projection of the parallelogram A B C D.

Find b the projection of B, by Problem 1. Produce B A and B C to meet I I in i^1 i^2, and join bi^1, bi^2. Produce A D and C D to meet I I in i^3, i^4. Draw i^3a parallel to bi^2, and i^4c parallel to bi^1, and the parallelogram abcd will be the projection of the parallelogram A B C D. This example is an illustration of Problems 1, 2, and 5.

Hence, if the projection of an angle be given, the projection of any point in either of the sides, containing that angle, may be found. Thus, let i^1bi^2 be the projection of the angle A B C, the projection of the point A may be found; for, draw Ai^3, parallel to B C, meeting I I in i^3. Draw i^3a parallel to bi^2, meeting bi^1 in a, and a is the projection of A.

Problem VII.

To find the Representation of any Rectilineal Figure whatever.

Find the projection of the vertex of one of the angles by Problem 1. Draw the diagonals of the primitive figure, from the vertex of which the projection is found to meet the intersecting line. Draw lines from each point so found in the intersecting line, to the point found, which is the projection of the vertex, and the lines thus drawn are the corresponding diagonals of the projection. Draw lines through each of the vertices of the primitive figure, except that of which the projection is found, perpendicular to the intersecting

line, to meet the corresponding lines. Join the unconnected points thus found in the same order as in the sides of the primitive figure, and the resulting figure will be the projection of the rectilineal figure or polygon required.

Example 1. Figure 2. Let the primitive figure ABCD be a pentagon. Find the projection $i^1 a i^2$ of the angle EAB, by Problem 3. Draw the diagonals $\text{A}i^3$, $\text{A}i^4$, to meet the intersecting line in i^3, i^4. Draw ai^3, ai^4, and these lines are the corresponding diagonals of the figure to be projected to the diagonals $\text{A}i^3$, $\text{A}i^4$ of the original figure. Draw B*b*, C*c*, D*d*, E*e* perpendicular to II, meeting ai^2, ai^3, ai^4, ai^1 in the points *b*, *c*, *d*, *e*, and lastly, join *bc*, *cd*, *de*, and the pentagon *a b c d e* is the projection of the pentagon ABCDE.

Example 2. Let the primitive figure be that of a hexagon ABCDEF, fig. 3. Find *a* the projection of A. Produce AB, AC, AD, AE, AF to meet II in i^2, i^5, i^4, i^3, i^1. Draw the lines ai^2, ai^5, ai^4, ai^3, ai^1; find the points *b*, *c*, *d*, *e*, *f*, as in Example 1. Join *bc*, *cd*, *de*, *ef*, and *a b c d e f* will be the projection of the primitive figure ABCDEF.

REMARK.

In the examples here given, if the primitive plane be revolved upon the intersecting line, until it makes an angle equal to the given angle contained by the two planes; then lines drawn through the vertex of every angle of the primitive figure, perpendicular to the plane of projection, will fall upon the corresponding vertices of the projected figure. Thus suppose, in figure 1, that the angle *b* E *n* is made to revolve on the side *n* E, until its plane become perpendicular to the plane $i^1 \text{b} i^2$; and suppose then, that the primitive plane $i^1 \text{B} i^2$, revolve on the intersecting line, the lines joining the corresponding points A, *a*; B, *b*; C, *c*; D, *d* will be perpendicular to the plane of projection.

Problem VII.

To find the Projection of a Circle.

Find the projection of the two diameters, of which one is parallel, and the other perpendicular, to the intersecting line, by Problem V. Upon the two

given lines thus found as axes, describe an ellipse, and it will be the representation of the circle required.

EXAMPLE.

Through the centre E, figure 4, draw B b perpendicular to the intersecting line, crossing it in F. Make the angle *nfb*, as in Problem 1, equal to the angle of inclination of the two planes. On the side *fb*, of the angle, make *fe* equal to F E, and *fb* equal to F B. Draw *e* c and *b* b parallel to the intersecting line, and let *e* c intersect B b in *e*, and *b* b in b. In e F, make e d equal to e b. Draw A a parallel, B b meeting *e* c in a. Make e c equal to e a; then a c is the projection of the diameter, which is parallel, and b d the projection of the diameter, which is perpendicular to the intersecting line. Upon a c and b d, as axes, describe an ellipse.

Problem VIII.

Knowing only the Angle of Projection, to find the Ratio between a primitive straight Line and its Projection, when the primitive Line is perpendicular to the primitive Plane.

Let *nfb*, Figure 4, be the angle of projection. In *fb*, one of the sides of the angle, take any point *h*, and draw *hi* perpendicular to the other side, meeting it in *i;* then any primitive line in the primitive plane is to its projection, when the said primitive line is perpendicular to the intersecting line, as *fh* to *hi*, that is, as radius is to the cosine of the angle of the inclination of the planes.

But if *fh* be the length of any primitive line, perpendicular to the primitive plane, *hi* will be the length of its projection.

Hence, the ratio of the projections of the two diameters of a circle, one of which is parallel to the intersecting line, and the other perpendicular to the primitive plane, are to one another as radius to the sine of the angle of projection.

PROJECTION OF SOLIDS.

In case of rectangular prisms, and even in parallelopipeds, one intersecting line will be sufficient to find the projection of the entire solid; but in projecting solids, of which its solid angles have more than three faces terminating in one vertex, it will be necessary to find an intersecting line for each face; this, however, we shall not attempt in this place, as such objects are seldom to be met with in the construction of Cabinet Furniture.*

Problem IX.

To find the Representation of a Cube, one of its Faces being given in Position and Magnitude.

Let the square ABCD, figure 5, be the given face, which we shall suppose to be the top of the solid in the primitive plane, the body being underneath.

Find a*bcd*, the projection of the face ABCD. Draw the straight lines *dg*, a*e*, *bf* perpendicular to the intersecting line. Make a*e* equal to the sine of the angle of projection, to a radius equal to the length of one of the edges of the cube. Draw *eg* parallel to a*d*, and *ef* parallel to a*b*, and *bcdgef* is the projection required.

OR THUS,

Having found a*bcd* the projection of the face ABCD, which is given in the primitive plane, let *e*F*a* be the angle of inclination of the two planes; and let F*a* be equal to FA. Draw *a*E perpendicular to F*a*, and make *a*E equal to the length of one of the edges. Complete the parallelograms a*dge*, a*bfe*, and we shall have the solid as before.

In the same manner the projection of the prism, figure 6, of which one of the ends is ABCD, will be found.

* Those who are desirous of obtaining a knowledge of the projection of the regular solids, will find ample instruction in Rees' Cyclopædia, under the article "Projection," see Plate I. by the author of this work.

PLATE V.

Problem X.

Given the Projections D A, D B, D C, Figure 1. *of the three Edges of the solid Angle of a rectangular Prism, and the intersecting Point* A, *of one of the Edges represented by* D A, *to find the intersecting Lines of the three Faces.*

Draw A B and A C respectively perpendicular to D C and D B, meeting D B and D C in B and C. Join C B, and A B, B C, C A are the three intersecting lines of the faces of the solid angle.

REMARK.

If the point A be not an intersecting point, the plane of the triangle A B C will be parallel to the plane of projection, and the three lines A B, B C, C A will be each parallel to the plane of projection.

Problem XI.

Given the three intersecting Lines A B, B C, C A, Figure 1, *of the Faces of a solid Angle of a rectangular Prism, to find the Projections of the three Edges.*

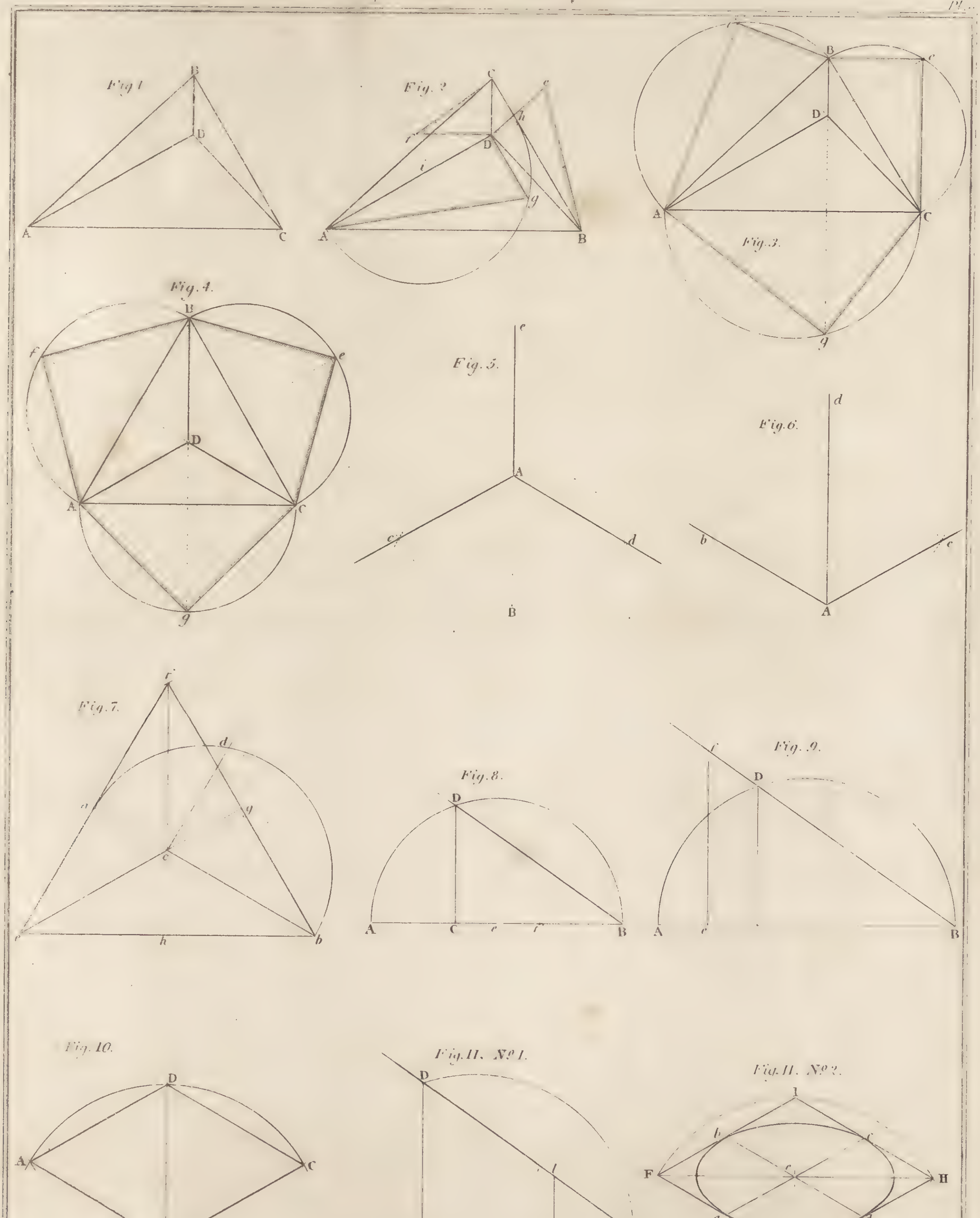
From the vertices A, B, C, of the triangle A B C, formed by the three intersecting lines, draw A D, B D, C D respectively perpendicular to the sides B C, C A, A B, and A D, B D, C D are the projections of the three edges, as required.

Problem XII.

Given the three intersecting Lines A B, B C, C A, Figure 2, *of the Faces of a solid Angle of a rectangular Prism, to find the Distance of the Vertex of the solid Angle from the Plane of Projection.*

Find A D, B D, C D, the projections of the three edges. Produce any one of them, as A D, to meet the opposite side in *h*. On A*h*, as a diameter, describe the semicircle A*gh*. Draw D*g* perpendicular to A*h*, and D*g* is the distance of the angle required.

Orthographical Projection.



Problem XIII.

Given the three Projections of the Edges of a solid Angle of a rectangular Prism, and the intersecting Point A, Figure 2, *of one of them, to find the Distance of the Vertex from the Plane of Projection.*

Find the three intersecting lines A B, B C, C A, by Problem I. Produce A D to meet the opposite side B C in *h*. On A *h*, as a diameter, describe the semicircle A *g h*. Draw D *g* perpendicular to A *h*, and D *g* will be the distance required.

To explain this principle to workmen, to an artisan, or to an amateur: let A D, B D, C D be the projections of three of the edges of a solid angle of a rectangular prism, and let A B, B C, C A be the three intersecting lines of the faces. On each of the three sides A B, B C, C A, as diameters, describe respectively the three semicircles A *f* B, A *e* C, C *g* A. From the point D draw D *f*, D *e*, D *g* respectively perpendicular to A B, B C, C A. Draw A *f*, *f* B; B *e*, *e* C; C *g*, *g* A. Then the triangle A *f* B, being revolved on the line A B, the triangle B *e* C revolved on the line B C, and the triangle C *g* A revolved on the line C A, as axes, until the three vertices *f*, *e*, *g* coincide, it is evident that the solid angle of a rectangular prism will be formed by the three right angles, and that the point D will be the projection of its vertex. This may be done with a stiff piece of paper or pasteboard, by drawing a point, not quite sharp, along the lines A B, B C, C D, with a moderate degree of pressure, so as not to cut the paper or pasteboard, in order to make the three triangles turn more freely upon the said three lines. By uniting the three primitive planes in this manner, it is obvious that any one of them, and its projection, are both in a plane perpendicular to the plane of projection; and it is also obvious, that if the three intersecting lines be equal in length, the three projections of the edges must be also equal in length, and will divide the circumference of a circle, described from the projection D of the vertex, into three equal parts, see figure 4, so that each of the angles must be 120°, therefore, when this happens to be the case, the projections of the three

edges of every solid angle of a rectangular prism must either be 120° or 60°; that is, they will either be, as in figure 5, where each is 120°, or, in figure 6, where the two lines A*b* and A*c* make 60° each, with the middle line A*d*.

This case has been most absurdly called isometrical perspective. It has nothing to do with perspective; since no point, however distant, can ever project the object on a plane, by lines radiating from that point, and passing through the lines of the object, to meet corresponding lines in the plane of projection; yet the eye is not only talked of, but a line of sight also. The question may be fairly asked, In what point of the line of sight must the eye be placed in order to project an object isometrically? If the eye be placed in any point of the diagonal of a cube, and if the plane of projection be perpendicular to this diagonal, the edges of the solid angle will certainly be projected, so as to make each of the angles they contain 120°; but this equality will not obtain in more than one of the solid angles of a parallelopiped, this being the form in which framed work and machinery are usually arranged.

Projection is a general name, that not only applies to the representation of objects formed by perpendiculars from the object to the plane of projection, but also to radiating lines passing through the object to the plane of projection, or radiating lines intercepted by the plane of projection. When a new science is invented, it must have a new name. New names to inventions, previously known by other names, convey an erroneous idea of the thing intended. And as this case of orthographical projection is founded upon the common principles of the science, and is the same in practice as when the three lines which form the projections of the angles of a cube are unequal, and since it offers nothing in point of facility to the delineator, except that of taking the measures from one scale, it is not a separate species of projection, but a particular case of orthographical representation, and therefore it is not entitled to any name distinct from that to which it belongs.

There will, however, be no impropriety in applying a single word of qualification, in order to save the explanation of a circumstance which would otherwise require several words; we shall, therefore, make use of the word

Isometrical adjectively, in order to accompany the substantive Line, when this line is one of the three edges of a solid angle of a cube, or of a rectangular prism, which are equally inclined to the plane of projection.

Problem XIV.

To find the Inclination of any One of the three Edges to the Plane of Projection.

Draw any straight line A B, figure 8, and in A B set off three equal parts of any length from A to B, marking the divisions C and *f*. From the middle point *e*, of A B, with the radius *e* A, or *e* B, describe the semicircle A D B. Draw C D perpendicular to A B, and join B D; then A B D will be the angle of inclination required.*

OR THUS.

In any straight line B C, figure 8, set four equal parts of any length each, and let C *e* be a fourth of C B. Draw C D perpendicular to C B from *e*, with the distance *e* B, describe an arc at D; join B D, and C B D is the angle required.

* In order to shew that *a c*, figure 7, is one-third of the perpendicular *a b*, we see that the two right-angled triangles *e a c* and *f a c* are equal to each other, for *e f* is bisected in *a*, and the angles *a e c* and *a f c* opposite the common perpendicular *a c*, are each 30°, and each of the angles *e c a*, *f c a* are therefore 60°; therefore the two triangles *a c e* and *a c f* might be formed into one equilateral triangle, by uniting the legs *a e* and *a f*, so that the point *e* might coincide with *f*, and *a* with *a*, and placing the right angles adjacent in the same plane, then *a c* would be half one of the sides, viz. equal to the half of *c e* or *c f*; that because *c e*, *c f*, and *c b* are equal, *a c* would be the half of *c b*, and therefore one-third of *a b*. Hence *a c*, *c b*, and *a b* are respectively as 1, 2, 3.

This is the foundation of the above construction. The method of finding the angle, which each of the edges makes with the plane of projection, is preferable to any other method hitherto given. This angle is the principal thing required by the draughtsman, he has no need of number; however, as the numerical ratios are very easily derived from the construction, we shall shew how this may be done; for this purpose, *c d* is a mean proportional between *c a* and *c b*; therefore, *c d* $= \sqrt{2}$, *a c* being 1, and *c b* 2; then, with reference to figure 8, we have B C $=2$ and C D $=\sqrt{2}$; hence B D $=\sqrt{(\overline{BC}^2 \times \overline{CD}^2)} = \sqrt{(4+2)} = 6$; therefore C D, C B, B D are as $\sqrt{2}$, 2, $\sqrt{6}$, and multiplying these by the $\sqrt{2}$, they become 1, $\sqrt{2}$, $\sqrt{3}$.

As to the angle of inclination of the primitive line, and the plane of projection, it is nearly equal to 35° 16°, for considering radius equal 1, we shall have B D to D C, as radius to the sine of the angle of projection; that is, since BD $= \sqrt{6}$, and D C $= \sqrt{2}$, $\sqrt{6} : \sqrt{2} :: 1$: sine of the angle of projection $= \sqrt{\tfrac{1}{3}} = {}$·5773+ or more nearly ·5774— which answers to 35° 16′.

A REASON FOR THE TWO PRECEDING METHODS.

These methods are evident by considering figure 7, of which the equilateral triangle *bef* may be supposed to be formed, by the intersections of the three planes which constitute the solid angle. Since any edge of a solid angle of a rectangular prism, is always perpendicular to the plane passing through the other two; therefore, the primitive line, represented by *bc*, is perpendicular to the primitive plane represented by *ecf;* and consequently every section of the solid passing through the edge, of which *b c* is the projection, will form a right-angled triangle, of which the primitive vertex of the right angle is represented by *c;* and in the present case of equal inclinations of the edges to the plane of projection, if the plane of section be considered as perpendicular to the said plane of projection, the perpendicular *b a*, from any angle *b* to the opposite side *ef*, must be the base of the triangle.

Problem XV.

Given any Isometrical Length, to find the Primitive Length. Find A B D, Figure 9, *the Angle of Inclination.*

In one of the sides B A, containing the angle A B D, make B*e* equal to the length of the projection of the line. Draw *ef* perpendicular to B A, meeting B D, or B D produced in *f:* then B*f* is the length of the primitive line.

Problem XVI.

Given the Isometrical Length of the side of a Rhombus, representing a Square, to describe the Rhombus.

From any point B, in the straight line B D, figure 10, with a radius equal to the length of the line given, describe the arc A D C. From the point D, with the same radius, describe an arc on each side of the line B D, each intersecting the former arc in the points A and C. Join D A and D C; then A B C D is the rhombus required.

Orthographical Projections.

Fig. 2.

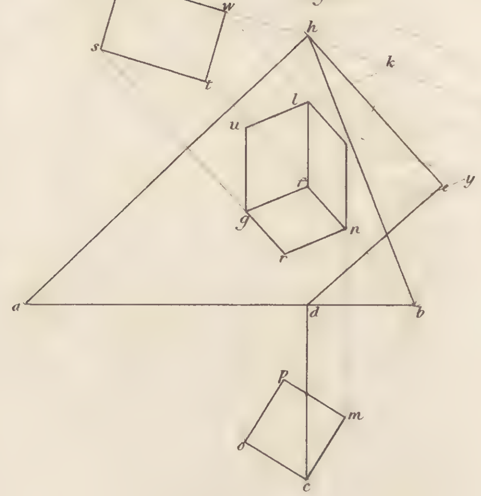


Fig. 1.

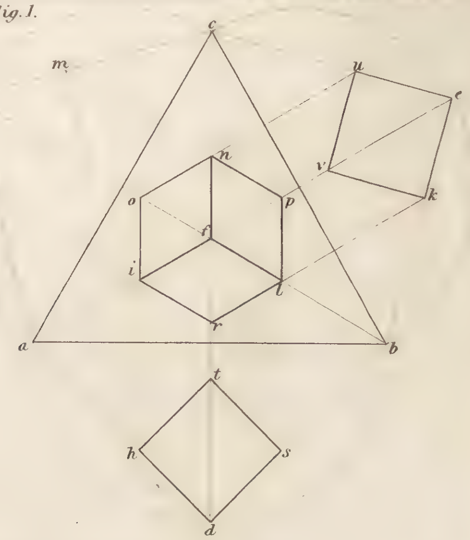


Fig. 3.

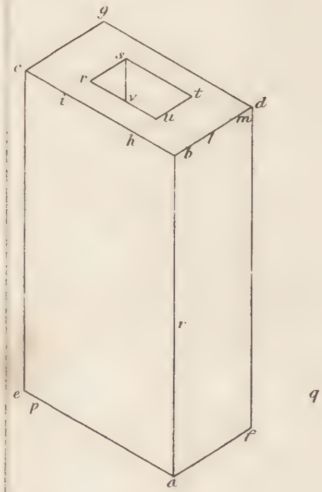


Fig. 4.

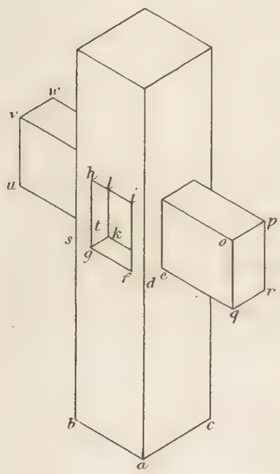


Fig. 5.

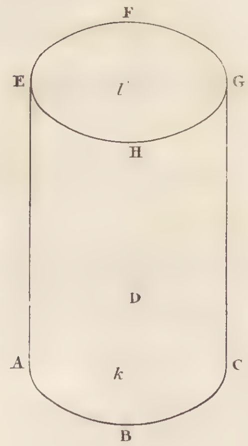


Fig. 6.

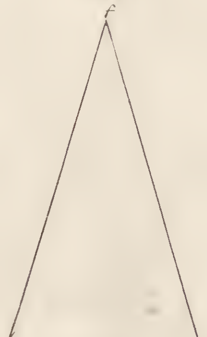


Fig. 7.

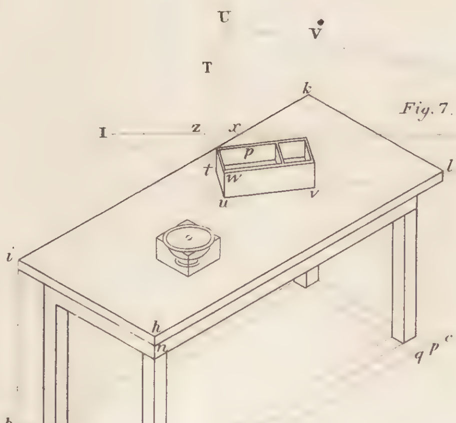
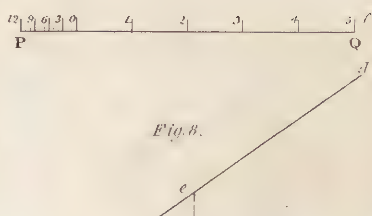


Fig. 8.



Problem XVII.

The Rhombus which represents a Square being given, to find the Axis of the Ellipse which represents the Circle inscribed in that Square.

Find the angle CBD, figure 11, No. 1, of inclination of the plane of projection, and the original plane. Let FGHI, No. 2, be the given rhombus which represents the circumscribing square. In BC, No. 1. make B*k* equal to the half of any one of the four sides; that is, because the rhombus consists of two equilateral triangles, equal to the half of the shorter diagonal, viz. equal to *e*I or *e*G, No. 2. Draw *kl*, No. 1, perpendicular to BC, meeting BD in *l*. Then B*l* is the semi-axis major, and *lk* the semi-axis minor of the ellipse which represents the primitive circle inscribed in the square, represented by the rhombus FGHI.

Having thus shewn the modes of constructing the projections of points, lines, surfaces, and solids, from their primitives, and the primitive figures from their projections; we shall now proceed with practical examples, which will at once shew the utility, the superiority, and the generality of our principles above those limited descriptions which may be elsewhere found.

PLATE VI.

Figure 1, exhibits the projection and development of a cube by the three right-angled triangles. The squares of the cube, which constitute the solid angle at the summit, are so placed that one of the right angles of each square may coincide with the right angle of each of the triangles; if these right-angled triangles be revolved on their hypothenuses *ab*, *bc*, *ca*, until the vertices *d*, *e*, *g* coincide, three sides to be projected of the solid, would then be brought into their real situation. Then the triangle *abc*, of which the sides are the three intersecting lines, being equilateral, the figure *airlpn*, of the contour of the projection, would be a regular hexagon, divided internally by the projections of the three edges of the solid angle into three equal rhombuses. In this case, all the edges are projected into equal straight

lines, which are equal to one another, and any primitive line is to its projection as $\sqrt{3}$ is to $\sqrt{2}$.

Figure 2, exhibits the development of the sides of a rectangular prism upon the three intersecting lines of their planes, supposed to be extended to meet the plane of projection in the straight lines *ab*, *bh*, *ha*, in the same manner as has been shewn for the cube, figure 1, except that the lengths are not projected into equal measures. In this example the ends are squares, hence the sides are equal rectangles. Because the plane angles, which form the faces of the solid angle, are right angles, they are all contained in a semicircle. Therefore having the three intersecting lines given, in order to prepare this development, we must first find the projection *f* of the vertex of the solid angle, by drawing lines from each of the three angles perpendicularly to their opposite sides. On each of the said three sides, as a diameter, describe a semicircle. Draw a straight line from *f* perpendicular to each diameter, to meet the semicircular arc; from this point of meeting, which is the vertex, draw a line to the extremity of each diameter. Place the end of the solid, which is a square in the right angle *acb*, and the side adjacent to this angle in the next vertex, so that the two edges of equal length may coincide, then the three sides being turned up as before, will exhibit the three sides of the primitive solid which are to be projected.

EXAMPLE I.

Find the representation of a prism, with a mortise cut from the upper end, according to given dimensions, by means of isometrical lines.

Make a scale P Q, of feet and inches, to any convenient size, as exhibited on the right-hand side of Plate VI, between figures 5 and 8, and let this scale be that from which the measures of the parts of the several diagrams of this Plate are taken.

Draw a straight line *ab*, figure 3, to represent one of the arrises of the prism, in the direction of its height. From *a*, as a centre, with any radius,

describe an arc *pq*, intersecting *ab* in *r*. From *r*, as a centre, with the same radius *ra*, describe an arc cutting the former at *p* on one side of *ab*, and at *q* on the other; and draw *ap* and *aq*, which produce if necessary. Suppose the length of the solid to be five feet nine inches, in the breadth three feet one inch, and the thickness one foot seven inches. From the scale PQ, take five feet nine inches, and apply the extent from *a* to *b*; take three feet one inch from the scale, and apply this extent in the line *ap*, or *ap* produced from *a* to *e*, and take one foot seven inches from the scale, and apply this distance from *a* to *f*. Having now the two sides *ab*, *ae*, complete the parallelogram *abce*; having the two sides *ab*, *af*, complete the parallelogam *abdf*; and having the two sides *bc*, *bd*, complete the parallelogram *cbdg*, which will complete the representation of the prism.

To exhibit the Mortise.—Suppose the mortise to be nine inches wide in the middle of the thickness; then as the thickness is one foot seven inches, by deducting nine inches, there will remain ten inches for the thickness of the two substances on each side of the mortise; hence the thickness of each is five inches. In the line *bd* make *bl* and *dm* each equal to the extent of five inches from the scale; draw the lines *lr* and *ms* parallel to the side *bc*. Suppose now the length of the mortise to be in the middle of the breadth of the prism, and to be one foot five inches, now the breadth of the prism being three feet one inch, deducting one foot five inches, there will remain one foot eight inches, which allows ten inches of substance at each end of the mortise; therefore, in the edge *bc* make *bh* and *ci*, each ten inches. Draw *ht* and *is* parallel to *bd* or *cg*, and the parallelogram *rstu* will be the upper end of the mortise. Draw *sv* parallel to *ba*, meeting *ru*, and the cavity will be exhibited by the two sides which join in *sv*.

Having gone through all the particulars in the construction of figure 3, a complete idea of that of every other prismatic solid, or any solid composed of prisms, may be easily conceived: we shall therefore only give the dimensions, and leave the construction as an exercise to the learner.

EXAMPLE II.

Construct a cross, having the transverse parts of a prismatic form, the one passing through a mortise in the other at right angles. The piece which contains the mortise to stand upon a square base, each side of the base to be seventeen inches; the length six feet seven inches; the distance of the arms from the base to be three feet three inches; the two arms of the cross to project equally on each side, and to be of the following dimensions, viz. the length of both four feet six inches; the breadth one foot two inches; and the thickness in the breadth of the solid, which contains the mortise, to be eight inches, and the arm to be fixed in the middle of the breadth which contains the mortise. Also, to represent a mortise in the other side of the same piece which contains the mortise already spoken of, at the same height as the former, and in the middle of the breadth, so that the breadth of this mortise may be equal to the breadth of the other, through which the transverse piece which forms the two arms passes, proceed as in Example I.

EXAMPLE III.

Represents a cylinder, five feet three inches in length, and three feet in diameter.

Let *cad,* figure 8, be the angle of projection. In *ac,* make *ab* equal to three feet of the scale PQ. Draw *bc* perpendicular to *ac,* meeting *ad* in *e;* then *ae* is the primitive measure of *ab.* In figure 8, draw AC, BD, at right angles, intersecting each other in *k.* Make *k*A, *k*C each equal to the half of *ae,* figure 8, and make *k*B, *k*D, figure 5, each equal to the half of *bc,* figure 8. Upon the lines AC and BD, as axes, describe the ellipse ABCD. Draw *kl* perpendicular to AC. Make *kl* equal to five feet three inches. Through *l* draw the lines EG, FH parallel to AC and BD. Make *l*E, *l*G each equal to *k*A or *k*C, and *i*H, *i*F each equal to *k*B or *k*D, and describe the ellipse EFGH. Draw the tangents AE and CG, which will complete the representation of the solid.

EXAMPLE IV.

Represent a right cone, so that the diameter of the base may be three feet, and the altitude six feet. — Find the base and height as in the cylinder. Draw lines from the vertex to touch the ellipse representing the base.

EXAMPLE V.

Represent a table, with a rectangular top and rectangular legs, framed to bearing rails; the top of the table being six feet in length, two feet ten inches in breadth, and two inches in thickness; the legs being three inches square, two feet ten inches in height under the table, making the entire height three feet; the bearing rails being six inches high, framed flush, with the legs on the outside; the outer surface of each side of the frame being four inches within each side of the table.—

We may commence the representation, figure 7, by making the angles *bah*, *cah*, as in Example I; or since the angles *hab*, *hac* are constantly the same, we may draw two contiguous angles of 60° each, any where on the paper out of the way, then draw the lines *ab*, *ah*, *ac* parallel to the sides of these angles: then, as we would wish the length to be represented on the left or on the right hand, we must place the length on *ab* or *ac* accordingly; the one being fixed, will determine the other. Let us suppose the length to be on the right, therefore make *ac* equal to six feet, and *ab* equal to two feet ten inches, and *ah* three feet. With the two sides *ah* and *ac*, complete the parallelogram *hacl*; with the two sides *ah*, *ab*, complete the parallelogram *habi*; and with the two sides *hi*, *hl*, complete the parallelogram *ihlk*, which will form the upper surface of the table. In the line *ac* make *af*, *cp*, each equal to four inches, and *fs*, *pq*, each equal to three inches. In the line *ab* make *ad*, *br*, each equal to four inches, and *de*, *rs*, each equal to three inches. Through the points *d*, *e*, *r*, *s*, draw lines parallel to *ac*, and through the points *f*, *g*, *p*, *q*, draw lines parallel to the side *ab*. The four parallelograms formed by the intersections of the lines parallel to *ac*, *ab*, are the

lower ends of the feet which stand on the floor. From the three angular points of these parallelograms nearest the bottom, draw lines parallel to ah, which will form the vertical faces of the legs. Make mn equal to two feet ten inches, and draw two lines parallel to ab and ac, to meet the two most remote lines of the legs, and these two lines thus drawn will represent the under lines of the bearing rails, and thus the representation of the table will be complete.

On the top of the table we have represented a cup or bason, as also a box at the farther end; the principles of our projection, by means of intersecting lines, will shew how this box may be drawn, according to given dimensions and in a given position.

Let the side of the box be placed accidentally upon the line uv, the corner being upon u. We shall suppose its form that of a rectangular prism as usual. Draw uU perpendicular to the horizontal planes, viz. parallel to the arrises of the legs of the table, and draw IL perpendicular to uU, intersecting each other in x. Draw uI parallel to the edge hi of the top of the table, and make xU equal to xI. Produce uv to L, and join LU. Draw Uz perpendicular to LU, meeting IL in z, and join uz. Suppose now that the length of this box is seventeen inches, the breadth nine inches, and the height four inches. Take seventeen inches, nine inches, and four inches from the scale PQ, and in figure 8, set off seventeen inches in the line ac, from a to f, draw fg perpendicular to ac, meeting ad in g; also, in ac set off nine inches from a to h, and draw hi perpendicular to ac, meeting ad in i. Transfer the distances ai, ag to the lines Uz, UL, from U to T and from U to V. Draw Tt and Vv perpendicular to IL, meeting the lines uz and uL in the points t and v. In uU make uw equal the height hm, from the scale PQ. Having thus obtained the lengths of the three ridge lines, the outline of the solid will be completed by drawing parallel lines.

REMARK.

This Example will shew the great extent and facility of our principles, that they are capable of representing lines and planes at any given angles with each other, and solids of all dimensions and proportions. The limited and

common place observations which were published for the use of practical men in 1825, and which are pretended to be new, apply only to lines in the direction of the three edges of the solid angles. They will not enable the student to find the proportions of the primitive lines, from their projections in any other direction. Our principles, on the contrary, not only shew how this is to be done, but direct us how to find the angle which is made, when one line is drawn to another line given in position, in order to represent a perpendicular, or to represent any given angle whatever; as also, how to draw a line parallel to a given line in projection, so that the distance of the two lines may represent a given distance. These positions are not only effected in the three planes which represent the solid angle of a rectangular prism, but in every other plane of which the position is given to any one of these three faces. Thus, if we know the inclinations of all the planes of a solid, however complex, and the figures of the several faces, we shall be enabled to represent that solid; and, on the contrary, if we have an orthographical representation, we may construct a solid similar to the original or primitive solid.

We shall not proceed any farther in the projection of objects by equal measures, since, though useful in the construction of mathematical diagrams, they form the angles which represent those of the solid much too acute in order to exhibit an agreeable representation, and since in point of facility nothing is gained by this case of orthographical projection. We shall, therefore, proceed with a general method, which does not require to be confined to any particular angles, as they may be assumed at pleasure. A scale may be readily found to each of the three directions, keeping still in view the projection of a solid angle, of which any one of the faces is perpendicular to the line of concourse of the other two.

Though the principles of these general methods have been long given by the author, he has never, till now, had an opportunity of exemplifying them in practice, except those two examples published in 1823, mentioned in the second note of the Introduction; he therefore trusts, that the superiority of his original methods to those more recently published, will be evident by a careful perusal.

If two angles of a projection of a right-angled solid angle be equal, and if any distance be taken upon the line between these equal angles, from the point where the three lines meet, and if upon this distance, as a diagonal, a rhombus be described, then the following proposition will obtain.

Either semi-axis of the ellipse, inscribed in the rhombus, is the hypothenuse of a right-angled triangle, of which each of the two legs is one-fourth of the diagonal, of which this semi-axis is a part.

This proposition is of the greatest use under the circumstance now mentioned ; for the rhombus being given, the two axes will be found instantly, without knowing the angle of inclination of the line which passes through the centre perpendicular to the plane of the circle, by drawing a right angle, and setting a fourth (say of the shorter diagonal) from the vertex upon each side of the angle, and transferring the distance between the two points of extension from the centre, upon the line intended for the minor axis, and the distance of the two remotest points will be the minor axis.

The following is another proposition, which will be found to be extremely useful.

The sine and cosine of the angle of inclination of any face of a right-angled solid angle to the plane of projection, are respectively equal to the cosine and sine of the line of concourse of the other two faces, to the said plane, and to the same radius, in both cases.

The number of propositions or theorems might have been extended, but as our work is designed for the use of practical men, and not for the speculative geometer, what are given will be sufficient to answer the purpose intended.

Before we commence our examples of representing solids in the form of rectangular prisms, by lines in given positions, the following observation will be found to be of great use to the student, viz. if the projection of one of the plane angles of a solid angle of a rectangular prism, and the intersecting line of that plane, be given, the intersecting lines of the other two planes may be readily found. Thus in figure 2, suppose we have the angle *afb*, which represents the projection of the right angle *acb*, and the intersecting line *ab*

given; the intersecting lines of the other two faces will be found thus: draw *bh* perpendicular to *af*, and *ah* perpendicular to *bf*, then the intersecting lines of the other two planes are *ah* and *bh*. Or, if we have the intersecting line of one of the faces of a solid angle of a rectangular prism, and the projection of that face, we may find the projection of the other two faces as before; for since four of the edges of the solid are always perpendicular to two opposite planes, the projections of these edges must also be perpendicular to the intersecting line of either of these planes; but the length of a straight line, perpendicular to a plane, is to the length of its projection as radius is to the sine of the angle of projection; therefore having the representation of one face of a rectangular prism, and the intersecting line, we have only to draw lines through the upper three points of each angle perpendicular to the intersecting line, then set off on the perpendicular which passes through the vertex of the angle at the summit, a length equal to the sine of the angle of projection, the primitive length being taken as radius. Or, suppose we assume the intersecting line *ab*, and the angle *afb* as the projection of one of the right angles at the summit, we may find the representation of the whole solid without using the angle of projection. Thus on *ab*, figure 2, as a diameter, describe the semicircle *acb*. Draw *fe* perpendicular to *ab*, and join *ac* and *bc*. In *ca* and *cb* make *co* and *cm* equal to the sides of the first face. Draw *og* and *mn*, meeting *fa* and *fb* in *g* and *n*. Find the intersecting *ah* as before. On *ah* describe the semicircle *avh*. Draw *fv* perpendicular to *ah*. Join *vh*. In *vh* make *vw* equal to the height of the solid. Join *fh*. Draw *wl* perpendicular to *ah*, meeting *fh* in *l*: by completing the parallelograms we have the representation required.

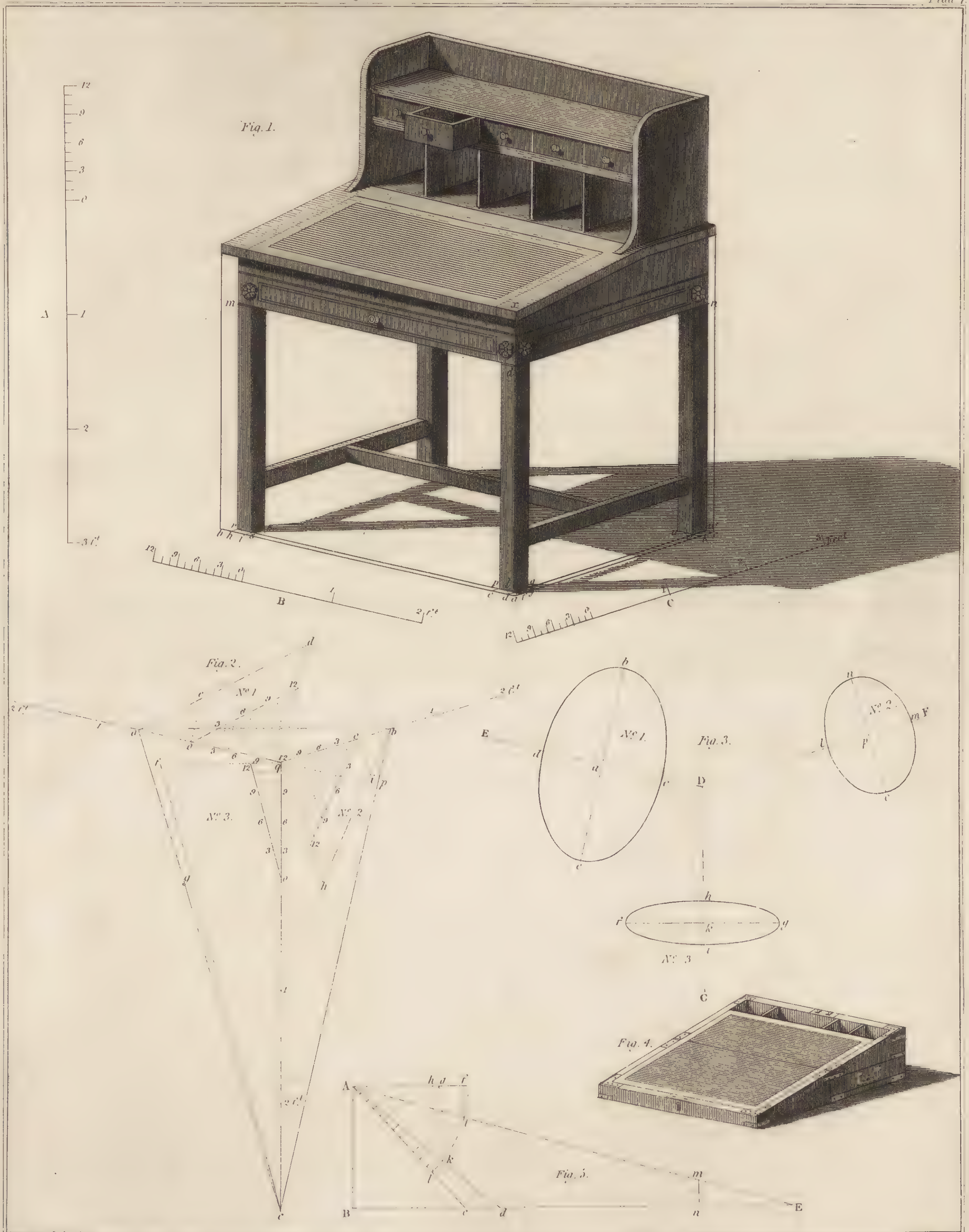
Examples in which a different Scale is used for each of the three Edges.

PLATE VII.

Example 1, figure 1. Represent a writing desk, with drawers, &c.

Draw *ax* as a director for the representation of the perpendicular lines, and draw *ab*, *ac*, making any angles with *ad* that may be agreeable to the eye, for the directors of the lines which represent the horizontal lines of the object. To find the scales agreeable to these three assumed lines, on any convenient part of the paper, as at figure 2: draw *qa*, *qb*, *qc* respectively parallel to *ab*, *ac*, *ax*, figure 1. Then proceed in figure 2, as follows. From any point *a*, in *qa*, draw *ab* perpendicular to *qc*, and *ac* perpendicular to *qb*, and join *bc*. Then if the three lines *qa*, *qb*, *qc* represent the vertical solid angle of a rectangular prism, *ab*, *bc*, *ca* will be the intersecting lines of the three faces. Produce *aq* to meet the opposite *bc* in *p*. On *ap*, as a diameter, describe the semicircle *adp*. Draw *qd* perpendicular to *aq*; then *qd* is the height which the apex of the cube is raised above its projection or seat *q*; therefore draw *qh* perpendicular to *qb*, and *qf* perpendicular to *qc*. Make *qh* and *qf* each equal to *qd*. Join *ad*, *bh*, and *cf*. Then will the three lines *ad*, *bh*, *cf* be the primitive lines, of which their projections are *aq*, *bq*, *cq*. Therefore we may assume in any one of the three lines *aq*, *bq*, *cq*, a scale of such a length as may be convenient for the size of the drawing. Let, therefore, in the line *qc*, the distance *qo* be taken to represent twelve inches, or one foot. Draw *og* perpendicular to *c q*, meeting *cf* in *g*; then *fg* is the length of a foot of the real object itself. In *da* make *de* equal to *fg*, and in *hb* make *hi* also equal to *fg*. Draw *eo* perpendicular to *aq*, meeting it in *o*; then *qo* is the length of a foot in the line *qa*; moreover, draw *io* perpendicular to *qb*, meeting *qb* in *o*; then *qo* is the length of the scale in the line *qb*. In each of the three lines *aq*, *bq*, *cq*, divide the distance *oq* into twelve equal parts as shewn, and repeat the distance of a foot as often as may be found

Orthographical Projections.



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necessary, and thus we have the three scales required in the three different directions. The method of applying these scales will be evident to most of our readers; but as there are some who do not comprehend so readily as others, we shall accompany our reader a little farther, and transfer these scales to A, B, C, parallel to the lines of which their lengths are to be taken.

Suppose the length of the flap or lid to be three feet three inches, the breadth two feet eight inches, and the height of the legs two feet, and the face of the rails to be one inch within the edges of the flap; the legs to be two inches square. As it will not be necessary to state the dimensions of all the parts, we shall now shew how the lines are to be represented as far as the dimensions are given.

Take three feet three inches from the scale B, and apply it on the line ab, figure 1, from a to b. Take two feet eight inches from the scale C, and apply it on the line ac, from a to c. In the lines ab, ac, make ad, af, bh, each equal to one inch. Also, make de, fg, hi, ch, each equal to two inches. Draw the lines fr, gt parallel to ab, and the lines dw, eu parallel to ac; proceed thus, and form the foot of the legs rst, plq, uvw. Draw ld parallel to ax, and make the height of ld equal to two feet from the scale A. Draw Dm parallel to ab, and dn parallel to ac. Having conducted the reader thus far in the delineation of this object, we shall now leave him, as it is presumed that he is sufficiently familiar with the method of proceeding to enable him to finish the drawing.

Example 2. Represent three circles perpendicular to three straight lines as axes, of which every two form a right angle; the representation of the three lines being DE, DF, DG, figure 3, parallel to qa, qb, qc, figure 2. Supposing the plane of the circle upon the axis represented by DE to be one foot one inch and a half from D, and the radius ten inches; also the plane of the circle upon the axis represented by DF to be two feet two inches from D, and the radius of this circle six inches, and the plane of the circle upon the line represented, DG, to be one foot two and a half inches from D, and the radius of this circle eight inches.

In the line DE make D*a* equal to one foot one inch and a half from the scale B, or from that of *q a*, figure 2, which is parallel to B. Through *a* draw *bc* perpendicular to DE. Make *ab*, *ac*, each equal to ten inches, taken from the oblique scale 0-12, No. 1, figure 2, parallel to *a d*. Place the foot of the compass in the same scale at 10, and fix the other foot at such a distance, as, by making it describe an arc of a circle, the arc will just touch the line *qa*; this may be done instantly by trial, without drawing a perpendicular to *aq*, or taking the length of the sine: this may also be otherwise expressed, by taking the shortest distance between the point 10 and the line *qa*. Transfer the distance thus obtained to figure 3, in the line DE, from *a* to *e*, and from *a* to *d*. Then the ellipse described upon the two axes *bc* and *de* will represent the circle required. In the same manner the ellipses at Nos. 2 and 3 may be drawn.

The reader is requested to find the dimensions of a portable desk represented by figure 4.

The method of finding the measure of a foot is shewn in figure 2, on each of the three directors, in order that the original measures may be brought into their real situation by turning up the three triangles of which the bases are the lines *q a*, *q b*, *q c*. This is certainly the most evident method of finding the proportions of the scales; but the following method is the most convenient.

Having drawn the three lines *qa*, *qb*, *qc*, figure 2, parallel to the three lines *ab*, *a d*, *ac*, figure 1, and the sides *ab*, *bc*, *ca*, figure 2, respectively perpendicular to the three lines *q c*, *qa*, *q b*, and having found the height *qd* from the vertex of the solid angle to its reach; proceed as follows:—

In figure 5, draw any straight line BE, and draw BA perpendicular to BE. Make BA equal to *q d*, figure 2. In figure 5, on the straight line BE, make BE, B*d*, B*c* respectively equal to *qc*, *qa*, *qb*, figure 2. In figure 5, join AE, A*d*, A*c*. Draw A*f* parallel to BE. Set off A*f* equal to twelve inches, or one foot, of the scale *qc*. Draw *fi* perpendicular to A*f*, meeting AE in the point *i*. From A, with the radius A*i*, cut the lines A*d*, A*c* in the points *k* and *l*. Cut the line A*f* in the points *g* and *h*, by the lines *kg*,

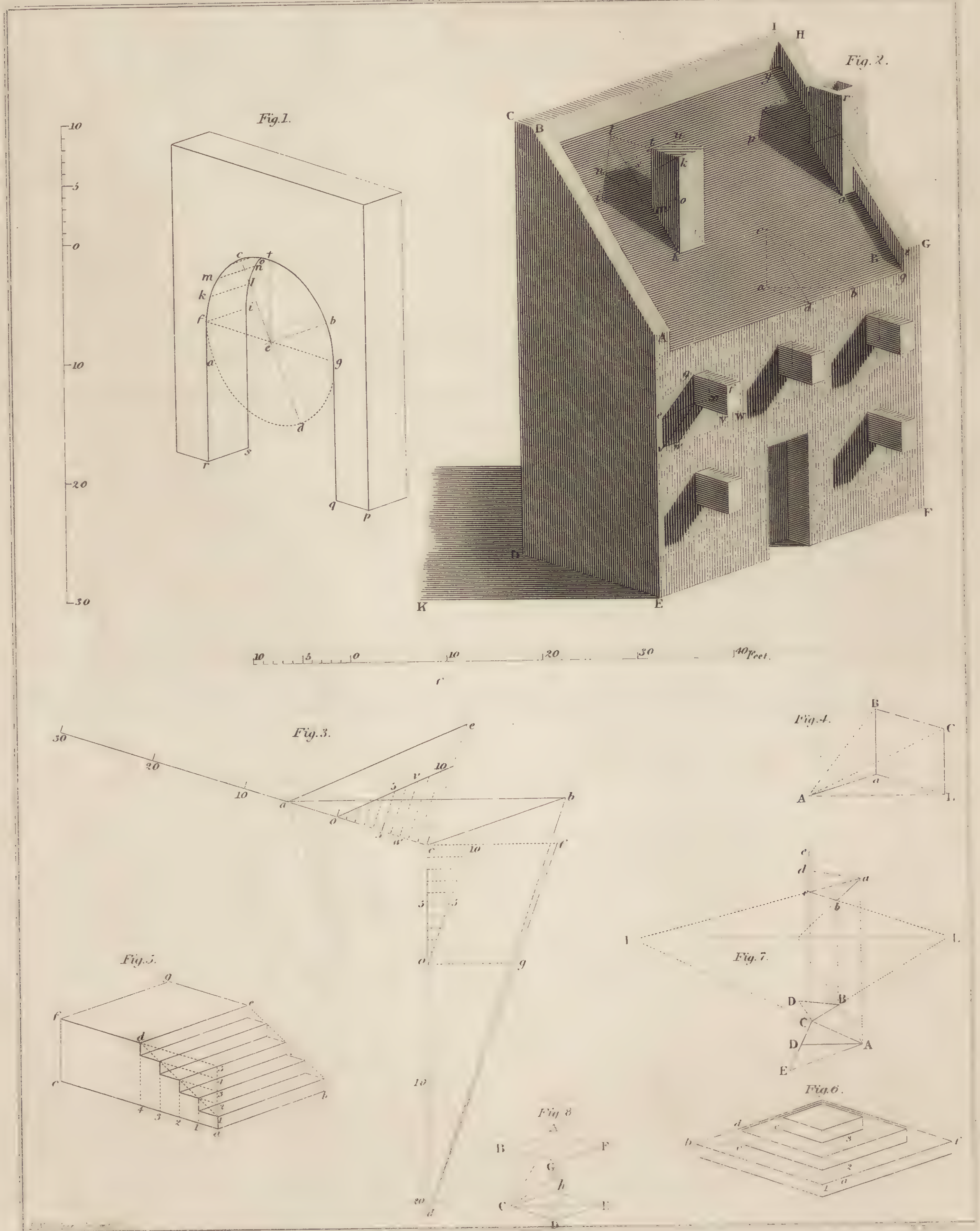


Fig. 1.
Fig. 2.
Fig. 3.
Fig. 4.
Fig. 5.
Fig. 6.
Fig. 7.
Fig. 8
40 Feet.

lh perpendicular to A*f*; then A*f* being the scale in the direction *qc*, figure 2, A*g* and A*h* will be the respective scales in the directions *qa*, *qb*, figure 2.

We have here in figure 5, preferred the line A*f* to B E, in order that the points *h*, *g*, *f* might not interfere with the points *c* and *d*, as otherwise they might have had some chance, or fall very near them.

This method is not only convenient in finding the lengths of the scales, but also in finding the two axes of the ellipse upon any one of the three directions.

Thus, suppose it were required to find the ellipse described round the, point *k*, figure 3, as a centre, to represent a circle, so that the primitive line of D G may pass through the centre of the circle as an axis. To do this in the easiest manner, it would be better to have a scale of the original measures as well as of the three directors, and this we have in any one of the three sloping scales, figure 2. Or the same may be obtained by dividing any one of the three radii A*i*, A*k*, A*l*, figure 5, into twelve equal parts. We may now recollect in example 2, that the radius of the original circle upon the line represented by D G, figure 3, was eight inches. Having drawn *fg*, figure 3, through *k*, perpendicular to D G, take eight inches from the scale A*l*, figure 5, and in figure 3 make *kf* and *kg* equal to it; set the distance *kf* or *kg*, figure 3, or eight inches in the line E A, figure 5, from E to *m*. Draw the sine *mn*, and transfer *mn* to figure 3, from *k* to *h*, and from *k* to *i*; then *h i* is the semi-axis minor

PLATE VIII.

EXAMPLE.

Represent a semicircular arch in a straight wall, of which the thickness is four feet, the distance of the arch from the corner of the wall three feet and a half, the breadth of the arch fourteen feet, the height from the bottom of the wall to the springing fifteen feet.

In figure 3, draw the lines *ca*, *c b*, *cd* in any directions that may be agreeable to the eye, or which the subject to be delineated may require, the directors of the horizontal lines being *ca*, *cb*, and that of the vertical lines being *cd*. In this example the right angles of the solid angle are respectively 143°, 108°, and 30°, the horizontal right angle in front being represented by an angle of 143°, and each of the right angles in the two vertical planes by 71°, 30′, which is the half of 143°. In figure 3, the angle *acb* is therefore 143°, and each of the angles *acf*, *bcf*, is 71°, 30′. To find the scale upon each of the lines *ca*, *cb*, *cd*, we may assume ten feet upon any one of these three lines, of such length as may be judged proper for the size of the drawing to be made. Suppose, then, in the line *c d*, which is the director of the vertical lines, that *co* is taken to represent ten feet; we have now to find ten feet in the lines *ca* and *cb*, or only in one of them, as they are equal. If the reader recollects the operation of finding the scales of the writing desk, figure 1, Plate VII. he will be at no loss to find the scales in this example; but if he does not, he must return to page 58, where the explanation of figure 1, Plate VII. is given. Let, therefore, *co*, in the line *ca*, be ten feet according to *co*, the assumed ten feet in the line *cd;* the sloping lines 0-10 and 0-10 being their originals.

Having fixed the position of the directors of the lines that are to represent the solid angles of the primitive object, and the scales in these three directions, we may now proceed to the delineation of the object.

In figure 1, draw *pr* parallel to its director *ca*, figure 3, and make *pq*, *qr* respectively three feet and a half, and fourteen feet from the scale *ca*. Draw *r s*, figure 1, parallel to the director *cb*, figure 3, and make *r s* equal to four feet from the same scale. In figure 1, draw *qg*, *rf*, *si* parallel to the vertical director *cd*, or *rf*, figure 3. In figure 1, make *rf* equal to fifteen feet from the scale *cd*, figure 3. In figure 1, draw *fi* parallel to *rs*, and *fg* parallel to *rp*. Bisect *fg* in the point *e*. We must now recollect that each of the three faces of a solid angle of a rectangular prism is perpendicular to the line of concourse of the other two; and that when an ellipse is represented in that face,

the axis minor is parallel to the line of concourse, and the axis major perpendicular to it. Therefore, through *e* draw *ab* parallel, and *cd* perpendicular to *rs;* then the axis major will be in the line *cd*, and the axis minor in the line *ab*. We have also to recollect that the axis major is to the axis minor, or the semi-axis major to the semiaxis minor, as radius is to the sine of the angle of the line of concourse of the two planes just mentioned to the plane of projection. Now *cb*, figure 3, is the representation of this line of concourse; but as *ca* is equal to *cb*, we must take our measures from *ca* instead of *cb*. Take, therefore, seven feet of the original scale of *ca*, figure 3, and transfer it to figure 1, in the line *cd*, from *e* to *c*, and from *e* to *d*. Now take the sine of the angle of projection to radius seven feet; that is, *vw*, figure 3, and transfer it in the line *ab*, from *e* to *a* and from *e* to *b*. Having now the two axes *ab* and *cd*, in position and magnitude, we may describe the ellipse or the part *fctbg*, which will represent the face of the arch. To represent the arch in the opposite face of the wall, draw *kl*, *mn*, &c. parallel to *fi;* make *kl*, *mn*, &c. each equal to *fi;* through the points *i*, *l*, *n*, &c. draw the curve *iln*, &c. to intersect the curve *fctbg* in the points.

A building, with arched apertures, requires more attention than one which has only rectangular apertures; for in the former case we are under the necessity of finding the original measures; but in the latter we only require the measure from the three scales of the edges of a solid angle. As every good draughtsman has such a command of hand as to describe a curve, through a few points, with sufficient exactness, and perhaps would not be at the trouble to describe portions of the ellipse required to represent the semicircular arch from the axis; and as he has now the four points *f*, *c*, *b*, *g* given, he may readily find the fifth point thus, which will enable him to trace it with great exactness. Draw *et* parallel to *rf*, and make *et* equal to seven feet, from the scale *cd*, fig. 3, and the point *t* will be the fifth point required.

EXAMPLES FOR PRACTICE.

Figure 5, exhibits the projection of a flight of steps, and figure 6, represents a series of return steps. These two examples are drawn on the same principles as the others, and therefore need not be explained.

Figure 7, exhibits the projection of a line, in a plane perpendicular to the primitive plane, and the projection of the intersection of that perpendicular plane, cut by another plane, of which its intersection and angle of inclination to the primitive plane are given.

Let IL be the intersecting line of the primitive plane, and the plane of projection; also, let AC be the intersection of the primitive plane, and the vertical plane. At any point B, in AB, draw BC perpendicular to AB, and draw CD′ perpendicular to BC. Make the angle CBD′ equal to the inclination of the inclined plane to the primitive plane. Draw CD perpendicular to AC, and produce CD to E. Make the angle CAE equal to the inclination of the line in the perpendicular plane, insisting upon AC. Find *abc* the projection of ABC. Draw *ce* perpendicular to IL. Make *cd*, *ce* equal to the sines of the angle of projection respectively to radius CD, CE; Join *ad* and *ae*; then *ae* is the projection of the line, and *ad* that of the intersection required.

This Problem is the same as finding the projection *ae* of a ray of light, and to find the intersection *ad* of a vertical plane, passing along that ray (*ae*) with a plane at the given angle CBD.

Hence, if *ab* represents one side of a building, and *bc* the other side, *ab* and *bc* will represent a right angle: and because *cd* represents a line perpendicular to the plane represented by *abc*, the line *cd* represents a line perpendicular to the line represented by *cb* and by *ca*. Hence, the angle *bad* represents the plane angle which forms the hypothenuse, and *bac*, *cad* represent the legs of a right-angled trehedral. *de* represents the elevation of the straight line CE above the inclined plane. Thus the use of this problem in the projection of shadows is manifest. We shall therefore leave its application, in the formation of certain shadows, to the reader.

With regard to the scales or lines of measure in the three directors, the measure, representing any length in the line opposite the greatest angle, is greater than the length taken upon either of the other two lines representing the same measure. On the contrary, the measure representing any length upon the line opposite the least angle, is less than the length taken upon either of the other two lines representing the same measure.

Hence, the three scales will be easily distinguished from each other wherever they are placed; or, in other words, it will be easy to see to which of the three directors any one of the three measures applies.

The three scales will be sufficient for any representation, of which all the parts of the edges of the original are straight lines, parallel and perpendicular to each other; but where circles are to be represented upon any of these lines as an axis, it will be necessary to find the inclination of each of the three edges of the solid angle, in order to find the two axes of the ellipse which is to represent the circle.

The most convenient method of finding the three inclinations is, perhaps, the following:—draw a straight line, as a base and a perpendicular, from any point to that straight line; set the height of the vertex of the solid angle upon the perpendicular, from the point of concourse of the two lines forming the right angle, also from the point of concourse set the lengths of the three lines which represent the three lines of concourse of the solid angle, upon the line representing the base; then join each of the three points to the top of the perpendicular, and the acute angle, which either of these lines makes with the base, is the angle of inclination.

N. B. The least inclination belongs to the director which is opposite to the greatest angle, and the greatest inclination belongs to the director opposite the least angle, representing a right angle of the solid angle.

PART II.—ORTHOGRAPHICAL PROJECTION.

ON SHADOWS.

We must here have the seat of the sun's rays and their angle of inclination to the horizon, to find the shadow of any vertical line, and the shadows of any line perpendicular to a vertical plane.

In order to find the shadow on the vertical plane, the seat of the sun's rays must be found on this plane.

The plane of the horizon is here represented by the primitive plane.

Let ABCDEFGHI, Plate VIII. figure 2, represent a penthouse or lean-to, with the ends of several timbers projecting from the front wall, also, with two stalks of chimneys, of which their planes are perpendicular to the horizon, and parallel and perpendicular to the plane of the front. All the walls, except the front, are higher than the sloping plane of the roof. The tops of the chimneys and the back wall terminate in horizontal planes. Moreover, the two gable walls terminate in planes parallel to the sloping side of the roof. It is required to find the shadow of the timbers projecting perpendicularly from the plane of the front, the shadow of the stack of chimneys, and the shadow of the gable wall on the inclined plane of the roof.

Let the line AL, figure 4, represent the seat of the sun on the horizon- Draw A*a* parallel to EF, the lower edge of the plane of the front, figure 2, and in AL, figure 4, take any point L, and draw L*a* parallel to ED, the lower edge of the gable, figure 2. Draw the line LC, figure 4, parallel to DC, EA, or FG, figure 2. Draw the angle LAC, figure 4, to represent the angle which a ray of the sun makes with its seat; then AC will represent a ray of the sun. Complete the parallelogram *a*BCL, and join AB, and BA will be the seat of the sun on the vertical plane.

To find the shadows of the timbers projecting from the front of the penthouse, figure 2. Let *gf* be the arris or edge of one of the timbers, perpendicular to the plane AEFG of the face of the front wall, *g* being the point

where the line gf meets the plane of the front. Draw ge and fe respectively parallel to B A and C A, figure 4, then the straight line ge is the shadow of gf. In the same manner the projection of the shadows of the other three perpendicular lines may be found. Now v being the shadow of the point V, and w the shadow of the point W, join ge, ev, vw, and wx, then $gevwx$ is the shadow of the end of the timber as required.

N. B. The edge ev of the shadow is parallel to fv the vertical edge, and vw to V W the horizontal edge of the timber; therefore if we find the seat of a ray of the sun to each of the three lines of the projecting end of the timber that throws the shadow, and having found the point e, in order to complete the shadow, we have only to draw ev parallel to fV, and vw parallel to VW.

In the intersection of the sloping plane of the roof and the face of the wall, take any length db. Draw da parallel to E D, and ba parallel to A L, figure 4; then the triangle abd represents a plane parallel to the horizon. Draw ac parallel to D C, E A, or F G, and draw dc parallel to A B or G H, and join bc; then bc is a section of a vertical plane, passing through the sun in the sloping plane of the roof.

To find the shadow upon the roof by the ledge G $z\epsilon$ H, first find the shadow of the vertical line yz thus, draw $y\beta$ parallel to be, and $x\beta$ parallel to C A, figure 4; then β will be the shadow of the point z. Draw $\beta\gamma$ parallel to $z\epsilon$, and $\beta\gamma$ is the shadow of the sloping line $z\epsilon$.

To find the shadow of either of the stalk of chimneys. To do this, it is only necessary to shew how one of the quoin lines of two adjacent vertical surfaces may be found; therefore let this vertical line be mt. Draw mn parallel to bc, and tn parallel to A C, figure 4; then mn is the shadow of the vertical edge mt of the stalk of chimneys. In the same manner the shadow of each of the other vertical lines may be found; then by joining all the parts, we shall have the shadow complete. Or if we had found the lines hi, mn, and os, and only the extremity of the shadow of the point k, produce hm and kt to meet each other in l; draw il, intersecting mn in n; draw ns parallel to tu, meeting os in s; then $hinso$ is the shadow of the chimney shaft as required.

It is now expected that the reader is in full possession of the principle, and therefore he cannot be at a loss to form the shadows of all objects, however varied in form from one another; we shall, therefore, close this subject by shewing how the ray and seat of the sun may be found, so as to cause all parallel planes, which are perpendicular to the surface of the wall, in vertical as well as in horizontal positions, to throw shadows equal to their breadth. In order to accomplish this, in figure 8, draw the cube ABCDEF. Draw the diagonal FC of the base CDE*h*; also, draw the diagonal FC of the vertical plane BCEF; then EC will be the seat, and FC a ray of the sun on the horizontal plane. Likewise, draw the diagonal AC, and AC is the seat of the sun on a vertical plane parallel to the plane ABCH. This position of the cube is adapted to the example, figure 2.

Having thus discussed the shadows of objects, projected orthographically, we shall now give a few of the principles for the shadows of bodies geometrically represented in planes, elevations, and sections, which in certain cases are indispensable to the draughtsman, and to fix those principles they will be illustrated by a select number of useful examples.

Problem XVIII.

The Seat and Angle of the Sun's Rays being given on any Plane, and the Line of Intersection of a Plane, perpendicular to the first mentioned Plane, to find the Seat of the Sun's Rays on the perpendicular Plane.

Let *ac*, figure 1, Plate VIII. be the intersection of the perpendicular plane, and *bc* the seat of the sun's rays. Make the angle *bcd* equal to the angle of inclination of the sun's rays. Draw *bd* perpendicular to *bc*, and *be* perpendicular, intersecting *ac* in the point *a*. Make *ae* equal to *bd*, and join *ec*. Draw *ef* perpendicular to *ec*, make *ef* equal to *bd*, and join *fc*.

In order that the reader may have some idea of the Problem, draw *bg* and *ah* perpendicular to *ba*, and make *bg* and *ah* each equal to *bd*, and join *gh*.

Conceive now the rectangle *abgh* to be turned upon *ab*, the triangle *cbd* to be turned upon *cb*, and the triangle *cae* to be turned upon *ca*, so that the

Fig. 1.

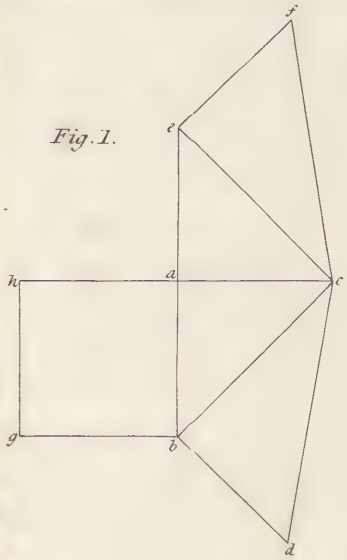


Fig. 2.

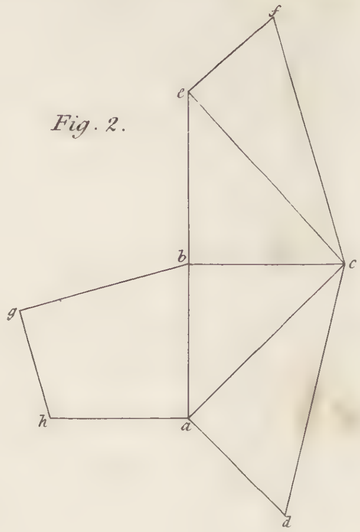


Fig. 3.

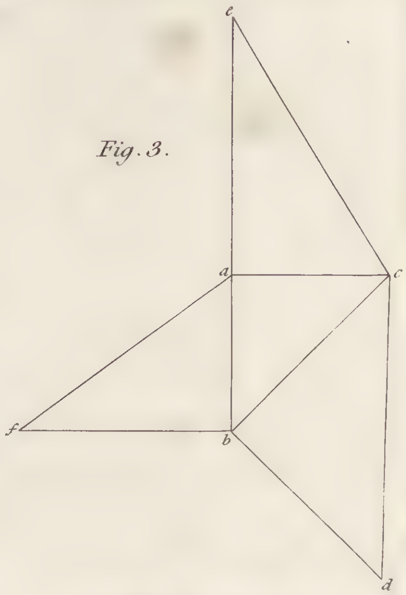


Fig. 4.

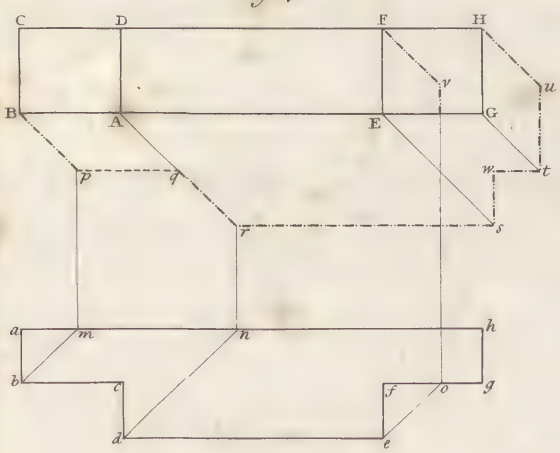


Fig. 5.

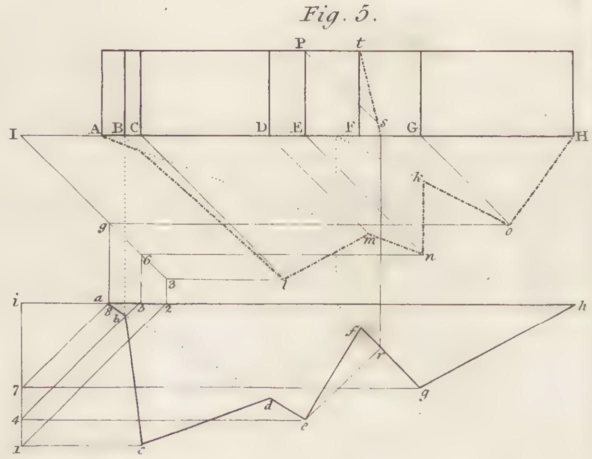


Fig. 6.

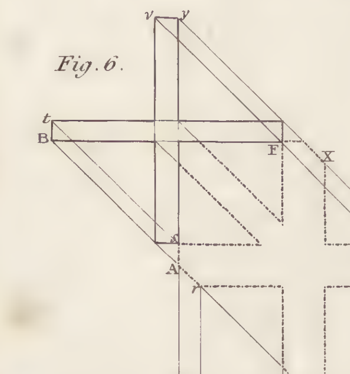
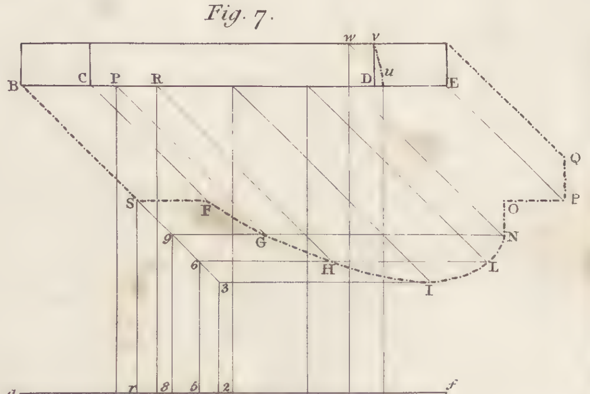


Fig. 7.



Designed by M.A.Nicholson

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planes of these three figures may be each perpendicular to the plane *cab*, then will *bg* coincide with *bd*, and *ae* with *ah*. These three planes being perpendicular to the plane *cab*, turn the plane *cef* round the line *ce* till it becomes perpendicular to the plane *cae;* then will the line *ef* coincide with *hg*, and the line *cf* will coincide with the line *cd;* and because the plane *cbd* is perpendicular to the plane *cab*, and *cb* is the foot of the plane *cbd;* therefore *cb* is the projection or seat of the line *cd* on the plane *cab*. In the same manner it may be shewn that *ce* is the seat of the line *cf*, that is, of *cd* in the plane *cbe*.

Problem XIX.

Given the Intersection cb, Figure 2, *of the Plane of Projection, and the Seat* ca *of a Line, the Angle which the Plane of Projection makes with the given Plane, and the Angle which the Line makes with its Seat, to find the Seat and Angle of Inclination of the Line on the Plane not given.*

Draw *ae* perpendicular to *bc*, intersecting *bc* in *b*, *ad* perpendicular to *ac*, and *ah* perpendicular to *ab*. Make the angle *adg* equal to the angle of inclination of the two planes, and the angle *acd* equal to the inclination of the line to its seat. Also, make *ah* equal to *ad*. Draw *hg* perpendicular to *bg*, and make *be* equal to *bg*, and join *ec*. Draw *ef* perpendicular to *ce;* make *ef* equal to *gh*, and join *cf;* then *ce* is the seat of the line, and *ecf* is the angle of inclination.

Problem XX.

Given bc, Figure 3, *the Seat of a Ray of Light, and the Angle of Inclination of the Ray to its Seat, also a Line* ac *parallel to a Line in Space, to find the Angle of Inclination of a Plane of Shade.*

Draw *be* perpendicular to *ac*, intersecting *ac* in *a*. Make the angle *bcd* equal to the inclination of the ray with its seat. Draw *bd* perpendicular to *bc*, and *bf* perpendicular to *ba*. Make *bf* equal to *bd*, and join *af*, then *baf* is the angle required.

Problem XXI.

To find the Shadow of a Solid upon a Wall, of which Solid its Planes are all parallel and perpendicular to the Plane of the Wall, given the Plan and Elevation of the Solid.

Let BCHG, figure 4, represent the elevation of the solid, the lines BC, AD, EF, GH, CH, and BG, represent the planes perpendicular to the wall, and the rectangles ADFE, ABCD, EFHG represent the planes parallel to the wall. Also, let *abcdefgh* represent the plan on a plane perpendicular to the plane of the elevation. In this plan, *ah* represents the wall line *bc*, *de*, *fg*; the planes ABCD, ADFE, EFHG.

Draw B*p*, A*r*, E*s*, G*t*, H*u*, parallel to the seat of the sun's rays on the elevation, and draw *am*, *dn*, *eo* and *gi* parallel to the seat of the sun's rays on the plan intersecting *ah* in *m*, *n*, and *fg* in *o*. Draw *mp*, *nr* perpendicular to *ah*, and *bg rs* parallel to it; *sw* parallel to *mp* or *nr*, *wt* parallel to BG, and *tu* parallel to GH; then B*pqrswtu*H is the shadow of the solid required.

From the description here given of figure 4, it will hardly be necessary to enter into any particular explanation of figures 5, 6, and 7. In figure 5, though only two of the planes are perpendicular, and the other are inclined to the plane on which the shadow is thrown, yet the lines of intersection of all the planes are either parallel or perpendicular to the plane on which the shadow is thrown; the principle then depends upon this Problem, "*the plan and elevation of a point being given, and the line of elevation, to find the shadow of the point in the elevation.*" Figure 6, exhibits the shadow of a cross; here all the lines are parallel and perpendicular to the plane of elevation. Figure 7, exhibits the shadow of any thing with a circular bow in front, SF and OP are the straight parts of the shadow, and are parallel to the lines BC and DE, which projects them; FGHILNO is the shadow of the circular edge, and as the shadow of a circle is either a circle or ellipse, so the shadow

of the segment of this circle is an ellipse, when the two planes are oblique to each other.

With regard to figure 5. continue the directions *ed, df* of the lines that run through the shadow to meet the wall line *ih,* and find the elevations of the same points, and these points will give the directions of the shadows *mn, po* on the elevation.

PERSPECTIVE.

Definitions, &c.

Def. 1. Perspective is the art of representing a rectilineal object upon a plane surface by lines, so that when the representation is placed in a certain position between the eye and the object, every line in the representation will intercept the view of the corresponding line of the object.

To render the principles of Perspective easy of comprehension, it is necessary to consider the faces of an object, as composed or formed of different planes, and one of those faces coincident with a plane indefinitely extended on all sides: this plane is called the *original plane*, or *geometrical plane*, and the face of the object which is coincident with the original plane, is called the original figure.

The point for viewing the object is given in position to the original plane; that is, some point is fixed upon in the original plane, and the eye at a given distance from that point in a perpendicular drawn from the said point.

Def. 2. The point where the eye is placed, is called *the point of sight.*

Def. 3. The foot of the perpendicular, is called *the station point.*

As the faces of an object may have all manner of positions, an original plane may in consequence have any inclination to the horizon; therefore an original figure may be in a horizontal plane, below or above the eye; a vertical plane on the right or on the left of the spectator; or on an inclined plane in any position to the horizon; but in whatever plane an original figure is situated, the method of representing the object is the same.

Def. 4. The surface on which the object is represented, is called *the plane of the picture*, or simply, *the picture.*

In order to have a comprehensive notion of the principles of perspective, the student must consider, that a picture drawn in the utmost degree of perfection, and placed in its real position, ought to appear to the spectator, the same as the real object itself, when seen from the point of sight. In order

to produce this effect, it is necessary that two visual rays, from any two points of the picture, should form the same angle, at the eye, as the visual rays from the two corresponding points of the original object; and that every ray, from the picture to the eye, ought to proceed with the same degrees of light, shade, and colour, as from the corresponding points of the original object. And there can be no doubt, that if these circumstances were attended to in the execution, the deception would be complete; so that if we were looking at the picture from its point of sight, our senses would be so far deceived, as to suppose that we saw the object itself, instead of its representation on a plane surface. This observation is completely verified by the Diorama now exhibiting in the Regent's Park.

Def. 5. That point in the picture, cut by a line drawn from the point of sight perpendicular to the picture, is called *the centre of the picture.*

Def. 6. The distance between the spectator's eye and the centre of the picture, is called *the distance of the picture,* or *principal distance.*

Def. 7. The point where any original line cuts the picture, is called *the intersecting point of that line.*

Def. 8. The line where any original plane cuts the picture, is called *the intersecting line of that plane.*

Def. 9. The point where a line, drawn from the eye of the spectator parallel to an original line, cuts the picture, is called *the vanishing point of that original line.*

Corol. 1. Hence it is evident, that original lines, which are parallel to each other, have the same vanishing point; for only one line can be drawn through the eye of the spectator that will be parallel to them all.

Corol. 2. Those lines which are parallel to the picture have no vanishing points; because no line can be drawn through the eye parallel to any one of them, that will ever meet the plane of the picture.

Corol. 3. The lines that generate the vanishing points of two original lines meeting together, form the same angle at the eye of the spectator, as the two original lines themselves.

Def. 10. The line formed in the picture, by a plane passing through the point of sight parallel to an original plane, is called *the vanishing line of that original plane.*

Corol. 1. Hence original planes, that are parallel, have the same vanishing line, for only one plane can pass through the eye of the spectator, that will be parallel to them all.

Corol. 2. All the vanishing points of lines, in parallel planes, are in the vanishing line of these planes; for the lines which produce those vanishing points are all in the plane that produces the vanishing line, by this definition.

Corol. 3. The planes which produce the vanishing lines of two original planes, have their common section in a line passing through the eye of the spectator parallel to the line of common section of the two original planes, and are inclined to each other in the same angle as the two original planes.

Corol. 4. Hence the vanishing point of the line of common section of two planes, is the intersection of the vanishing line of those planes.

Corol. 5. The vanishing and intersecting lines of the same original plane are parallel to each other, since they are generated by parallel lines.

Def. 11. The point in a vanishing line, cut by a perpendicular drawn from the eye of the spectator to that vanishing line, is called *the centre of the vanishing line.*

Corol. A line drawn from the centre of the picture to the centre of a vanishing line, is perpendicular to that vanishing line.

Def. 12. The distance between the eye of a spectator and the centre of a vanishing line, is called *the distance of that vanishing line.*

Corol. The distance of a vanishing line is the hypothenuse of a right-angled triangle, of which one leg is the principal distance, and the other is the distance between the centre of the picture and the centre of the vanishing line.

Def. 13. A plane passing through the eye of the spectator, parallel to the picture, is called *the directing plane.*

Def. 14. The representation of any figure, is called its *projection.*

Perspective.

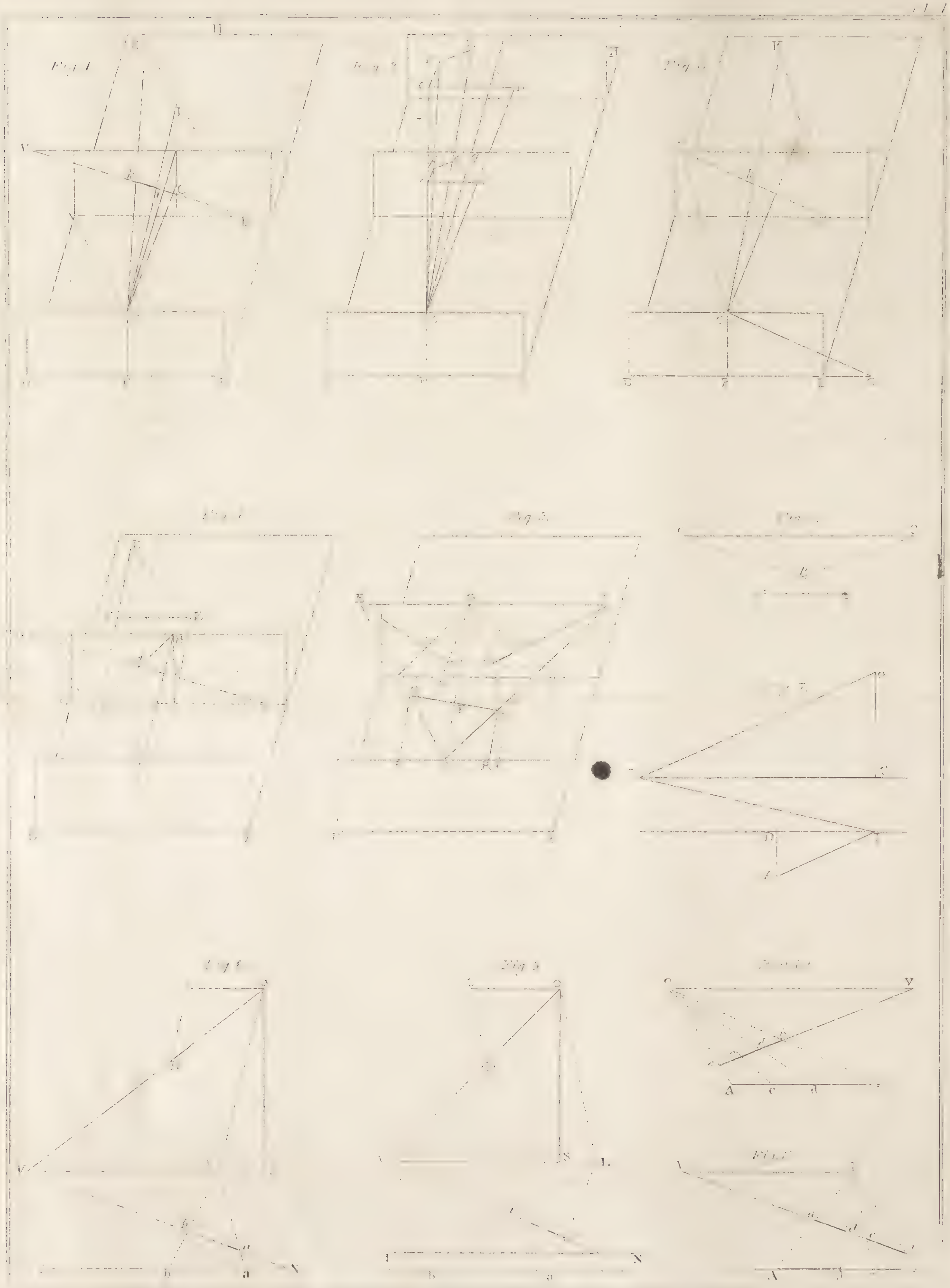


Plate I.—Perspective.

In order to comprehend the sense of these definitions more readily, let D E H, fig. 1, be the original plane, and let O be the point of sight, *Def.* 2, P the station point, *Def.* 3, and A B L the plane of the picture, *Def.* 4 : then if O C be perpendicular to the plane A B L, meeting it in C, C is the centre of the picture, *Def.* 5, and O C its distance, or the principal distance, *Def.* 6. If K I be an original line, and produced to meet the picture in B, B is the intersecting point of the line K I, *Def.* 7. If O V be drawn parallel to F, meeting the picture in V, V is the vanishing point of F G, *Def.* 9. If V L be drawn through V, parallel to the original plane D E H, V L is the vanishing line of that plane, or of D E H, *Def.* 10. If O S be drawn perpendicular to V L, to cut it in S, S is the centre of the vanishing line V L, *Def.* 11, and O S its distance, *Def.* 12, which is, therefore, the hypothenuse of the right-angled triangle O C S. If a plane, O D E, be parallel to the plane of the picture, O D E is called the directing plane, *Def.* 13.

PROPOSITION I.—THEOREM.

The representation of a line, is part of a line passing thruogh the intersecting and vanishing points of the original line.

Figure 1. For the visual rays I O, K O, &c. which produce the representations *i, k* of the points I, K, &c. of the original line I K, by their intersections with the picture, are all in a plane passing through the original line I K, and the spectator's eye is at O. But the point B, which is the intersection of the original line I K, is in that plane, because it is in the line I K ; and the line O V is in the same plane, because it is parallel to the original line I K, *Def.* 5 ; wherefore the line V B is the intersection of the plane I O K with the picture ; and consequently *i k*, which is the representation of the line I K, is part of the line K B which passes through the vanishing point V, and the intersection B of the original line I K.

Corol. 1. Hence the representation of any number of lines that are parallel to each other, but not to the picture, will pass through the same point. For

they all pass through the same vanishing point by this theorem, and by *corollary* 1, *Def.* 9.

Corol. 2. But if the original lines are parallel to the picture, as well as to each other, their representations will be parallel to each other, and to the originals. For the line passing through the spectator's eye, which line in other cases produces the vanishing point by its intersection with the picture, is, in this case, parallel to it, and therefore produces no vanishing point, so that the representations can never meet each other, nor that of the line passing through the spectator's eye, and consequently they are parallel to each other, to that line, and to the originals.

Corol. 3. Hence it appears, that the representation of plane figures, parallel to the picture, are similar to their originals. For in figure 2, the picture being A B, the original figure C D E F being parallel to it, and the representation being *cdef*. If the original figure be resolved into triangles, by diagonals as D F, the representation will be resolved into triangles by corresponding diagonals *df*. Whence all the lines in the representation being parallel to all the lines in the original, every triangle *edf* will be similar to the corresponding original triangle E D F; and consequently, all the lines in the representation *cdef* will be in the same proportion to one another as the corresponding lines in the original figure C D E F.

PROPOSITION II.—THEOREM.

Any line in the representation of a figure parallel to the picture, is to its original line, as the principal distance is to the distance between the spectator's eye and the plane of the original figure.

Let O G, figure 2, be perpendicular to the original plane and to the picture, cutting them in G and *g:* the original plane being parallel to the picture, therefore all the visual rays O C, O D, O E, &c. are cut in the same proportion, by the points *c, d, e,* &c. as O G is by the point *g;* and *dc* being parallel to D C the triangle, O*dc* is similar to the triangle O D C; therefore *dc* : D C : : O*d* : O D; but from what has here been observed, O*d* : O D : : O*g* : O G whence by

equality dc : DC : : og : OG, that is, representation cd is to its original line CD, as the principal distance og is to the distance between the spectator's eye and the plane of the original figure.

PROPOSITION III.—THEOREM.

The distance between the vanishing point of a line and the representation of any point in it, is to the distance between the vanishing point and the intersection, as the distance between the directing point and the intersection, is to the distance between the directing point and the original point.

Figure 3. Let B be the intersecting point, and G the directing point, of the original line IK, and V is its vanishing point; then k being the representation of K, and VB parallel to OG. Now the triangles OkV and KOG are similar; wherefore kV : OG : : OV : KG, but OG is equal to VB, and OV equal to GB; therefore kV : VB : : GB : KG.

PROPOSITION IV.—THEOREM.

The radial or parallel of an original line, producing the vanishing point, makes the same angle with the vanishing line as the original line makes with the intersecting line.

For the intersecting line, the vanishing line and the parallel of the eye are parallel to each other, and the radial, producing the vanishing point of an original line, is parallel to the original line; therefore whatever inclination the original has to the intersecting line, the radial of that line has the same inclination to the parallel of the eye; and because the vanishing line is parallel to the parallel of the eye, and the radial joins the parallel of the eye and the vanishing line; the acute angle, formed by the radial and the parallel of the eye, is equal to the acute angle formed by the same radial and the vanishing line, being alternate angles; therefore the acute angle, formed by the radial and the vanishing line, is equal to the acute angle formed by the original line and the intersection.

PROPOSITION V.—THEOREM.

If from any point B, fig. 4, taken at pleasure in the vanishing line A B, a straight line be drawn to any two points d and e in the intersecting line, so as to cut the indefinite representation A I of any original line in the points *d* and *e*, then will the radial O A be to the distance A B, between the vanishing point A and the assumed point B, as the original of *de* is to d e.

Produce the indefinite representation A I to meet the intersecting line in I: draw I D parallel to O A, and draw d D and e E parallel to O B, and through E draw E F parallel to G I.

Now because O B is parallel to d D and e E, and because O B meets the vanishing line in B, B is the vanishing point of the lines d D and e E; but d B and e B are the indefinite representations of d D and e E; therefore the representations of the original points D and E are in the lines d B and e B. Again, because O A is parallel to the original line D E, and because O A meets the vanishing line A B in A, A is the vanishing point of the original line D E, and since I is its intersecting point, A I is the whole indefinite representation of D E; therefore the points D and E are represented in the line A I; but since they are also represented in d B and e B, the points *d* and *e*, the intersections of these three lines, are the representations of D and E.

Then because of the similar triangles O A B and D E F, O A : A B : : D E : E F; but E F is equal to e d, and D E is the original of *de*, whence O A is to A B, as the original of *de* is to d e.

Corol. Hence if the length of the original of *de* be known, d e will be found, and consequently *de*, without having D E in its real position.

PROPOSITION VI.—THEOREM.

If the angle E O F, fig. 5, formed by the radials of any two indefinite representations *a* E and *b* F, be bisected, and if from the point G in the vanishing line, cut by the bisecting line, be drawn lines G a, G c, G b, and G d, cutting each indefinite representation in two points, and any line drawn parallel to the

vanishing line in four points a, c, b, d, then the originals of the two intercepted distances *ac, bd,* in the indefinite representations, will be to each other as the corresponding intercepted distances a c, b d, on the line drawn parallel to the vanishing line.

Take O Q in the one radial at pleasure, and make O S on the other equal to O Q, and join Q S, which will be bisected in T by O G. Now in the two right-angled triangles O T Q and O T S, the base T Q is equal to the base T S, and the perpendicular T O is common, therefore the hypothenuse O Q is equal to the hypothenuse O S. Draw Q P and S R parallel to O G, and through O draw P R parallel to the vanishing line E F; then P R will also be bisected in O; produce O R to any point U, and draw U V parallel to O G, cutting O F in V.

Now by the preceding proposition O E is to E G as the original of *ac* is to a c, and O F is to F G as the original of *bd* is to b d; but by the similar triangles O E G and Q O P, O E : E G : : O Q : O P; therefore the original of *ac* is to a c as O Q is to O P: again, in the similar triangles O F G and S O R, O F : F G : : O S : O R; therefore the original of *bd* is to b d as O S is to O R: and because U V is parallel to S R, the triangles O U V and O R S are similar; whence O V : O U : : O S : O R : but O P is equal to O R, and O Q equal to O S; whence O V : O U : : O Q : O P, hence, alternately O Q : O V : : O P : O U; therefore the original of *ac* is to the original of *bd,* as O P to O U, or O R to O U; whence if O P or O R be equal to a c, and O U equal to b d, O Q and O V will be the originals of *ac* and *bd.*

PROPOSITION VII.—PROBLEM.

Given the centre and distance of the picture, and the seat of a point on the picture, and its distance from it, to find the representation of that point.

Let C, figure 6, be the centre of the picture, S the seat of the given point. Through C and S draw at pleasure C O and S P parallel to each other; make C O equal to the distance of the picture, and S P equal to the distance of the original point from its seat S. Draw O P and S C, cutting each other in *p*, which will be the representation of the original point required.

For imagine the eye of the spectator to be placed at O, and P to be the original point in their proper places; then will O P be a visual ray, projecting the point P at p; and because of the similar triangles p S P and p C O, S p : : p C : : S P : C O; therefore Sp + pC : pC : : SP + CO : CO, or CS : Cp : : SP + CO : CO : now CS, SP + CO and CO are constant quantities; therefore the distance Cp is invariable, and consequently the point p must also be invariable.

Hence the point p may be found by calculation thus:—SP + CO : CO : : CS : Cp = $\frac{CO \times CS}{SP + CO}$ which is the distance of the point p from C, the centre of the picture.

PROPOSITION VIII.—PROBLEM.

Given the centre and distance of the picture, the intersecting point of an original line, and the seat of the line on the picture, and the inclination of the line to its seat, to find the vanishing point of the original line and its indefinite representation.

Let C, figure 7, be the centre of the picture, I the intersecting point of the original line, and I D its seat.

Make the angle D I A equal to the angle which the original line makes with its seat I D; draw C V parallel, and C O perpendicular, to I D, and make C O equal to the distance of the picture. Draw O V parallel to I A, and join I V; then V will be the vanishing point, and I V the indefinite representation of the original line.

Suppose the triangles C V O and D I A to be turned round the lines C V and I D; C V I being turned towards the front, and D I A on the back, of the picture, so that each two adjoining planes may be perpendicular to each other, then the point O will be in the point of sight, and I A will be the original line; then O V will be still parallel to A I; therefore O V will be the radial of A I, V its vanishing point, and I V its indefinite representation.

PROPOSITION IX.—PROBLEM IV.

From a given point in the indefinite representation of a straight line, to cut off a part of that indefinite representation that shall represent a given portion of the original.

METHOD FIRST.

Let *a* V, fig. 8, be the given indefinite representation; it is required to cut off from *a* V a part which shall represent a line of a given magnitude, V L being the vanishing line, Plate X.; O the point of sight, and I N the intersecting line.

Through O draw C O parallel to V L; make O D equal to the original line. In V L take any point L, draw O L and D C parallel to O L. Draw L *a*, cutting I N in a; make a b equal to O C, and join L b, cutting *a* V in *b*, then *ab* is the part required.

This method is excellent when only one or two distances are required to be ascertained; but when many are wanted, the following method will be found to be productive of very great facility.

The principle and methods of performing this operation are quite new, and entirely free from the defects of the method first introduced by Dr. Brook Taylor, and in practice in every recent publication founded upon his principles.

METHOD SECOND.

The same data being referred to by the same letters, will be known by the preceding diagram.

Draw O C, figure 9, parallel to V L; make O C equal to the distance between the vanishing line V L and intersecting line I N; then the point L being taken as before, draw O L and C D parallel to O L. Make the distance between the vanishing line V L and the parallel line a b equal to O D. Through L draw L *a*, which produce to meet b a in a, and make a b equal to the length of the original line, and join b L, cutting *a* V in *b*, then *ab* is the line required.

This depends upon the same principle as the foregoing method.

These methods have the peculiar advantage, that the measuring centre may be placed on any point of the vanishing line, and consequently may be brought immediately over the representation of the line to be divided; by this means the dividing lines cut the representation given more directly or less obliquely than the usual process.

In the common method the measuring point cannot have any change, and as it is always situated at a distance from the centre of the vanishing line, the intersections made in this indefinite representation are so very oblique, that the points required must, in fact, be guessed at. Taking given portions of the distance of a vanishing point, as $\frac{1}{2}$, $\frac{1}{3}$, $\frac{1}{4}$, $\frac{3}{4}$, &c, is very troublesome, and does not always obviate the inconvenience.

PROPOSITION X.—PROBLEM V.

To divide the representation of a line, whose vanishing point is given, into any number of parts, so that their originals shall have a given ratio among themselves.

Let *a b*, figure 10, be the given representation of the line to be divided, and V its vanishing point.

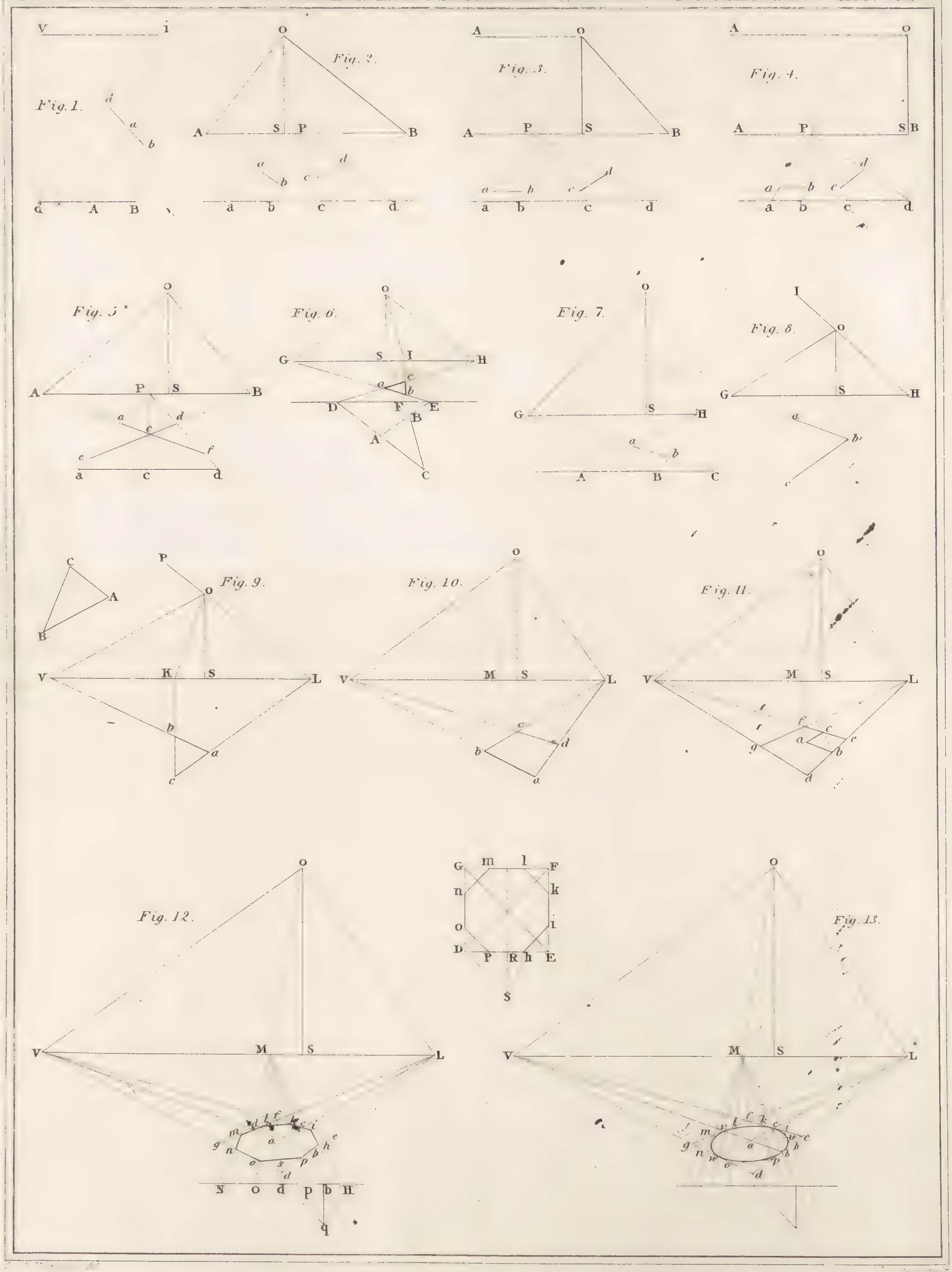
Draw V O at pleasure, and draw A B parallel to V O. Through any point O, in the line V O, draw O *a* and O *b*, cutting A B in A and B: divide A B in *c*, *d*, &c. in the given ratio, and draw O C, O D, &c. cutting *a*, *b* in *c*, *d*, &c. then *a*, *b* will be divided as required.

For C V being parallel to A B, A B may be considered as the original line, and O V its parallel; and consequently O as the point of sight, and O A, O C, O D, &c. visual rays, projecting the points *a*, *c*, *d*, &c.

PROPOSITION XI.—PROBLEM VI.

From a given point in a given indefinite representation of a line, to cut off a part, of which the original shall have a given ratio to the original of another given part of that indefinite representation.

Perspective.



Published by H. Fisher, Son & Co. Caxton, London, Sep. 1834.

Let *b* V, figure 11, be the given indefinite representation of the line, V its vanishing point, *bc* the given part; it is required to cut off from *a* a part of which the original shall have a given ratio to the original of the part represented by *bc*.

Through V draw V L at pleasure, and A B parallel to V L, and at any distance from V L draw L *c* and L *b*, which produce to meet A B in C and B; also draw L *a*, cutting A B at A: make A d equal to B C, in the ratio required, and join d L, cutting *b* V at d, then the original of *ad* is to the original of *bc* as A d is to B C.

This is evident by considering it upon the same principle as that in the preceding proposition.

The above Problem very frequently occurs in the following case, viz:—supposing *ab* to be given in perspective, it is required to cut off a part, *ad*, from *a*, so that the originals of *ad* and *ab* may have a given ratio. The description is shortly thus—

PLATE XI.

Draw L *a*, L *b*, figure 1, cutting A B at A and B; make A d equal to A B in the ratio required; join d L, cutting the indefinite representation V *b* as required. Or if *ad* is given, *ab* may be found exactly in the same manner.

PROPOSITION XII.—PROBLEM VII.

At a given point in the indefinite representation of an original Line, to represent a Line equal to, or in a given Ratio to, the original of another given Line, the vanishing Line, and the proposition of the Eye, being given.

CASE FIRST.

Let A B, figures 2, 3, and 4, be the vanishing line, O the point of sight, *ab* the given indefinite representation, A its vanishing point; *c* B the indefinite representation from which the part is required to be taken, and *c* the point at one of its extremities, and let B be the vanishing point of *c* B.

Parallel to A B draw any straight line ad; oin A O and B O, and draw O P, cutting A B in P, so that the angle A O B may be bisected. Draw P *a*, P *b*, P *c*, cutting ad in a, b, c. Make cd to ab in the ratio required, and join P d, cutting *c* B in *d*, then the original of *ab* will be to the original of *cd* as ab is to cd.

In figures 3 and 4, as *ab* is parallel to the vanishing line, the radial O A is also parallel to the vanishing line. In figure 4, the angle A O B being a right angle, and being bisected, B P will be equal to B O, the distance of the picture.

CASE SECOND.

Suppose the points *b* and *c* to coincide, then the points b and c will also coincide. In this case let *b* become *c*, and b will also become *c*; the operation will still continue to be the same, except there is only one line to produce nstead of the two P *b* and P *c;* but that the method may be clearly understood, we shall shew the construction according to this simplification, particularly as this case more frequently occurs than the other.

Parallel to A B, figure 5, draw any straight line ad. Draw P *a*, P *c*, meeting ad in a and c; make cd equal to ca, in the ratio of the two original lines, and join P *d*, cutting *c* B in *d*. Then the original of *ab* will be to the original of *cd*, as ca is to cd.

This method obtains the result, whether the two lines lie on both sides of the line P c, or on the same side of it.

Hence it is evident, that if ca and cd be equal to each other, the original lines, represented by *ca*, *cd*, *ce*, and *cf*, will be all equal to each other.

But here it may be observed, supposing D A and F B not to be parallel, that is, to incline to each other, that we should not have had more trouble in representing the triangle A B C, figure 6, formed by producing D A and F B to meet each other in C; so that to find the representation of a triangle in the original plane, we have only to produce the three sides, and find the indefinite representations of these three sides, as the triangle *abc* is the representation of the original triangle A B C.

This same idea will extend to all kinds of right-lined figures, by merely finding the indefinite representations of the sides of the original figure, without resolving it into triangles; and their mutual intersections with each other, will form the representation of that figure, whatever it may be.

This method is so evident, that more examples will not be necessary, and more particularly as the figures, being drawn out in their real places, would be attended with great inconveniences, and would require more surface to draw upon than can generally be found.

The principle will be clearly understood by turning the plane Y upon the plane of the picture towards the eye, and the plane X behind the picture, so that the planes X and Y may be parallel to each other; then the picture and the other two planes being supposed to be transparent, and the eye placed at O, each indefinite representation will intercept the view of its original, whether point or line.

PROPOSITION XIII.—PROBLEM VIII.

Given the vanishing and intersecting Lines of a Plane, the Centre and Distance of the vanishing Line, to find the Projection of any Line, or Side of a Figure, given in the original Plane.

Let GH, figure 6, Plate XI. be the vanishing line, S its centre, and let the intersecting line be DE.

Draw SO perpendicular to GH, and make SO equal to the distance of the picture.

Then to find the representation of the straight line AB, in the original plane X, folded on the plane of the picture, as well as the vanishing plane Y.

Draw OG parallel to AB, meeting the vanishing line GH in G, and produce AB to meet the intersecting line in E, then E is the intersecting point of AB; join GE; and GE is the indefinite representation of AB. Now, to find the representation of any point in the original plane, we must make two lines pass through that point, and find the indefinite representations of these two lines, and their intersection will give the representation of that point. With

respect to the representations of the points A, B, which mark the extremities of the original line A B: a common indefinite representation G E has been found for each of the points A, B; then as one indefinite representation has been found for each point, we have only to find another for each of these points; therefore, draw any line A D, and find its indefinite representation D H, also any line B F, and find its indefinite representation F I, then the intersections *a* and *b*, of these two indefinite representations, mark the extremities of the line *ab*, which is the representation of A B as required.

PROPOSITION XIV.—PROBLEM IX.

Given the vanishing and intersecting Lines of a Plane, and the Centre and Distance of the vanishing Line, to find the original of a given Representation.

Let it be proposed to find the original of the triangle *abc*, fig. 6. Produce the sides *ba*, *ac*, *bc*, of the given representation to their vanishing points G, H, I, and to their intersecting points E, D, F, and draw the radials G O, H O, I O; draw E A parallel to O G, D C parallel to O H, and F C parallel to O I, then the triangle A B C, formed by the intersections of these three parallels, will be the original of the triangle *abc* as required.

This is evident from the last proposition being only the reverse of it.

PROPOSITION XV.—PROBLEM X.

Given the vanishing and intersecting Lines of a Plane, and the Centre and Distance of the vanishing Line, to find only the Length of the Original of a Projection given.

Let G H, fig. 7, and A B, be the intersecting and vanishing lines, S the centre of the vanishing line G H, O the point of sight placed as usual, and *ab* the given projection or indefinite representation.

Produce *ba* to its vanishing point G; join G O, and make G H equal to G O. Draw H*a* and H*b*, cutting the intersecting line A B in A and B; then A B will represent a distance equal to the original of *ab*.

Demonstration. Let C be the intersection of the given representation *ab*. Now G H being equal to G O, the distance of the vanishing point G, and A C being parallel to G H, the point H may be considered as the point of sight, and A B C as the original line, H A and H B, as visual rays, producing the projection or indefinite representation *ab*.

PROPOSITION XVI.—PROBLEM XI.

Given the vanishing Line of a Plane, the Centre and Distance of that vanishing Line, and the vanishing Point of a Line in that Plane, to find the vanishing Point of another Line in the said Plane, so that the two original Lines shall form a given Angle.

Let G H, figure 8, be the vanishing line, O the point of sight, and G the given vanishing point situated as before.

Join G O. Draw O H, making the angle G O H equal to the given angle, then H is the vanishing point required.

If the sides of the original angle produced are not subtended by the intersecting line, make the angle G O I, not subtended by the vanishing line, equal to the original angle, and produce I O to meet the vanishing line in H, then H is the vanishing point required.

This is evident, since the radials make the same angle at the point of sight that the originals make with each other.

PROPOSITION XVII.—PROBLEM XII.

Given the vanishing Points of an Angle, and the Representation of the Angular Point, to represent that Angle.

Let G and H, figure 8, be the vanishing points, and *b* the representation of the angular point; then if the original angle is subtended by the intersecting line, draw *b*G and *b*H, and G*b*H will be the representation required.

But if the original angle is not subtended by the intersecting line, produce G*b* or H*b*, according to which side it may lie upon; suppose H*b* produced to *c*, then the angle G*bc*, or *abc*, will represent the angle required.

PROPOSITION XVIII.—PROBLEM XIII.

Given the vanishing Line of a Plane, the Centre and Distance of the vanishing Line, and the Representation of one Side of a Triangle of a given Species in that Plane, to find the Projection of the whole Triangle.

Let V L, figure 9, Plate XI. be the vanishing line, S its centre, and O the point of sight as before, and *ab* the representation given.

Produce *ab* to its vanishing point V, or let V be the vanishing point of *ab;* and let *ab* subtend the angle, which is also subtended by the intersecting line. Make the angle V O K equal to the original of the angle at *b*, the side O K cutting V L in K; draw K *bc*, and suppose the original of the angle at *a*, not subtended by the intersecting line: make the angle V O P equal to the original of the angle *a*, and produce P O to its vanishing point L, and draw L *ac*, then *abc* is the triangle required.

OR THUS.

Draw A B, fig. 9, parallel to V O. Then on A B describe a triangle similar and similarly situated to the original triangle. Draw O L parallel to A C, and O K parallel to B C; then the intersections of these lines give the vanishing points L and K; then the angles, subtended by the intersecting line, will be the opposite angles to those subtended by the vanishing line; therefore the same angles of the triangle A B C, that are subtended by the vanishing V L, will have their representations also subtended by the vanishing line V L; and the same angles in the triangle A B C, of which the contained sides would meet the vanishing line when produced to form an opposite angle, will have their representation also subtended by the vanishing line; thus the angle *acb* represents an angle equal to A C B, and the angle *cba* represents an angle equal to C B A; because A B and C B would meet the vanishing line the same as *ab* and *cb*.

PROPOSITION XIX.—PROBLEM XIV.

Given the Vanishing Line of a Plane, and the Centre and Distance of the Vanishing Line, and the Representation of any Side of a Figure in that Plane, to find the Representation of the whole Figure.

Resolve the original figure into triangles, by means of diagonals, and find the representations of these triangles one after the other, by Proposition XVIII. beginning with the triangle which has the line given, then every triangle, as it is represented, will give a new line for the next to be represented.

EXAMPLE.

Given the Vanishing Line of a Plane, the Centre and Distance of the Vanishing Line, and the Representation of one Side of a Square, to find the Representation of the entire Figure.

Let V L, figure 10, be the vanishing line, S its centre, O the point of sight as usual, and let *ab* be the representation of the given side.

Produce *ab* to its vanishing point V, if not already done; join V O, and draw O L perpendicular to V O. Draw O M, bisecting the angle V O L, and meeting the vanishing line V L in M. Also, draw *a* M and L *b*, cutting each other in *c*: again, through *a* and *c* draw *a* L and V *c*, cutting each other in *d*; then *abcd* is the representation of the square required.

The representation of a square is described with great ease, knowing that the diagonal being drawn, bisects the opposite angles; and by attending to the foregoing instruction, the representations of figures with more sides may be executed with equal facility.

PROPOSITION XX.—PROBLEM XV.

Given the Vanishing Line of a Plane, the Centre and Distance of the Vanishing Line, and a Line representing a Perpendicular drawn through the Centre of a Square to one of its Sides, to describe the entire Representation of the Square.

Let V L, fig. 11, be the vanishing line, S the centre of the vanishing line, and O the point of sight as usual. Also, let *a* be the representation of the centre of the square, and *ab* the representation of the perpendicular.

Produce *ba* to its vanishing point V; then having drawn VO and OL perpendicular to VO: draw OM, bisecting the angle VOL, and cutting the vanishing line VL in M; then M is the vanishing point of the diagonal of the square. Draw M*a* and L*b*, cutting each other in *d;* also draw M*b* and *a*L, cutting each other in *c*. Through *c* draw V*c*, cutting *d*L at *e*, and *d*M at *f;* lastly, draw L*f* and *d*V, cutting each other at *g;* then *defg* is the representation of the square required.

This method is evident, since a line drawn perpendicular from the centre to one of the sides of a square makes half a right angle with either of the diagonals; therefore *b*M must cut *ac*, to represent a line equal to the line represented by *ab*.

This operation is also evident from the next Proposition.

PROPOSITION XXI.—PROBLEM XVI.

Given the Vanishing Line of a Plane, the Centre and Distance of the Vanishing Line, and a Line representing a Perpendicular drawn through the Centre of an Octagon to one of its Sides, to describe the entire Representation of the Octagon.

Complete the square *defg*, fig. 12, as in the last Proposition. Draw NH parallel to VL. Produce M*b* and M*d* to meet NH at b and d. Draw bq perpendicular to NH, and make bq equal to bd, and join dq. Make dH and dN each equal to dq; bp equal to bH, and do equal to dp. Draw MN, cutting the sides *gf* and *gd* of the square at *m* and *n;* and draw MH, cutting *ed* and *ef* at *h* and *i;* draw OM, cutting *gf* and *gd* at *l* and *o*; and, lastly, draw PM, cutting *ef* and *ed* at *k* and *p*. Draw *lk* and *op*, then *hiklmnop* is the representation of the octagon required.

This method is evident from the construction of the real octagon, (see the adjacent figure,) for it is well known that each side of a regular octagon is equal to the difference between the side and diagonal of a square having the diameter of its inscribed circle equal to that of the octagon. Now DR is half

the side of the square, and since RS is equal to DR or RE, DS is therefore equal to half the diagonal; and RH, which is half the side of the octagon, is equal to the difference between the half diagonal and half side of the octagon.

PROPOSITION XXII.—PROBLEM XVII.

Given the Vanishing Line of a Plane, the Centre and Distance of the Vanishing Line, and the Representation of the Centre and Radius of a Circle, to complete the whole Representation of that Circle.

It is known that a circle in perspective is an ellipsis, for it is demonstrated by writers on conics, that the section of a cone is an ellipsis. Now the representation of a circle is the section made by the plane of the picture intercepting the rays which proceed from the original circle to the eye, and which form a conic surface, consequently the representation is an ellipse. Therefore in order to form the curve correctly, we must find its axis, or such diameters that it may be described by continued motion.

But though the difficulty of doing this is not very great, yet to understand the principle thoroughly requires more geometrical knowledge than most people are possessed of. We shall, therefore, shew how to find a convenient number of points, or of points and lines representing as many points of the original circle; which, when ascertained, the curve must be drawn through them by hand, observing the elliptic figure, which will greatly contribute to the accuracy of the representation.

METHOD FIRST.

Let *ab*, figure 13, represent the given radius, the vanishing line and its centre and distances being as before.

Find the representation *hiklmno* of the octagon, as in the preceding Problem. Produce *ab* to cut the opposite side *ml* in *v*, and produce *ca* to cut the side *no* at *w:* let the diagonal *fd* cut the two sides *lk*, *op* in *r* and *s;* draw the diagonal *ge*, cutting *mn* and *hi* in *t* and *u*, then through the eight points *b*, *u*, *c*, *r*, *v*, *t*, *w*, *s*, draw the curve of an ellipse; which may be very

correctly done, since the circle is supposed to be inscribed in the octagon, its representation will touch the representation of the octagon; therefore the eight points of representation are as many points of contact, which are equivalent to sixteen points, without tangents.

When the representation is very small, we need not be at the trouble to represent the octagon, the four points *b*, *c*, *v*, *w*, in the representation of the sides of the square, will be sufficient; for these being points of contact, the curve may be drawn with considerable accuracy. However, in most cases it would be eligible to find the sides *mn* and *hi* of the representation of the octagon, as also the points of contact *t* and *u*, which would limit the length of the curve with much greater accuracy than would otherwise be obtained, and this may be done without increasing any confusion of lines, even though the curve should be ever so narrow, or ever so near the vanishing line.

This is one of the best practical methods that has ever been invented. In short, the operation is not only performed with fewer constructive lines, but with much more facility, and the curve described with greater accuracy than has been done by any other method hitherto published.

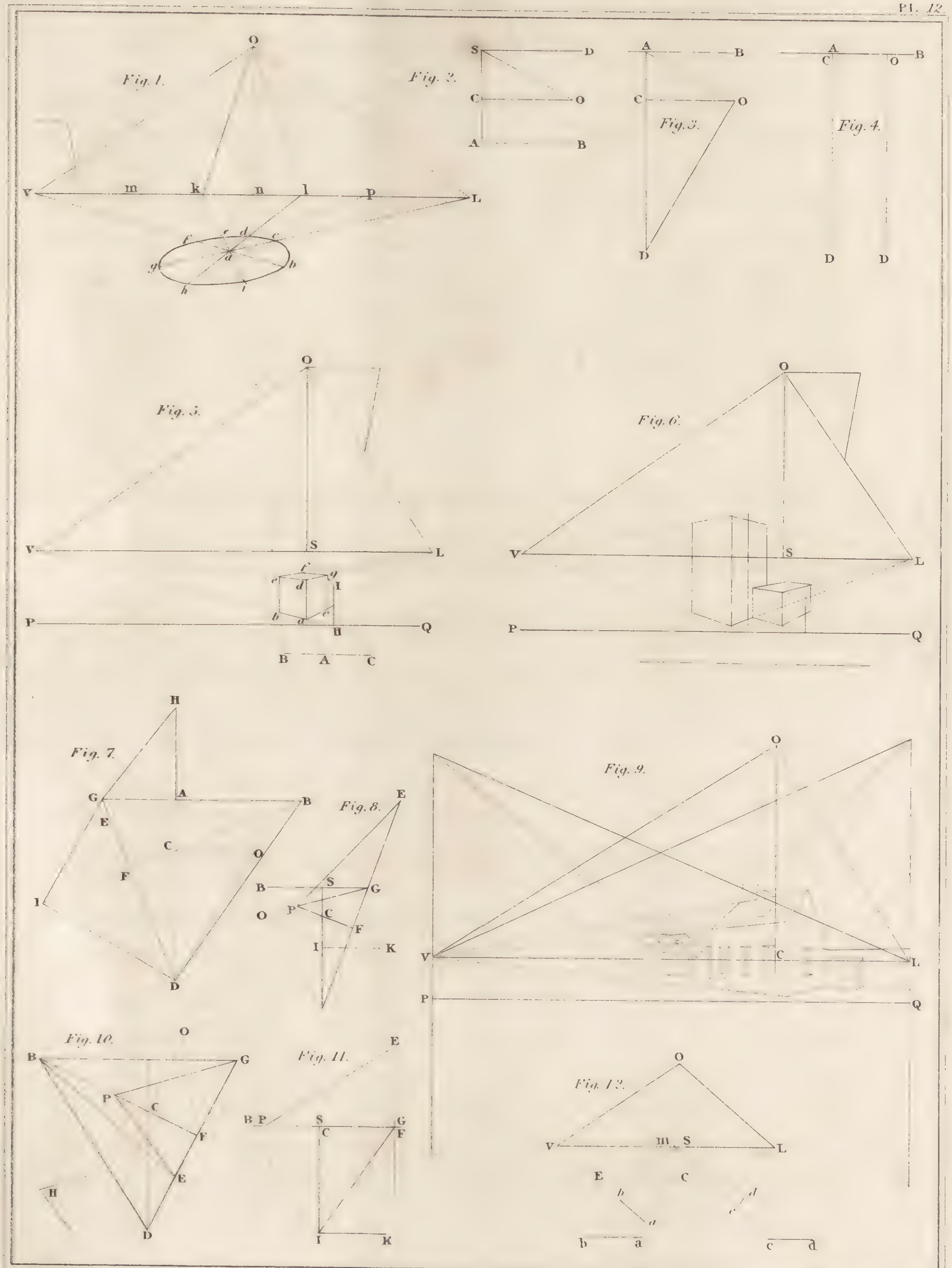
PLATE XII.

METHOD SECOND.

The data, fig. 1, being as before, produce the representation *ab* of the given radius to its vanishing point v. In the vanishing line v L, take any number of vanishing points k, l, L, &c.: and draw the radials v o, k o, l o, L o, &c.: through the representation of the centre *a* draw the indefinite radii v*b*, k*i*, l*h*, L*g*, &c. Make *af* to represent a part equal to the part represented by *ab* by Proposition XI. Bisect the angles v o k, k o l, l o L, &c. and let the bisecting lines meet the vanishing line in m, n, p, &c.

Through one extremity *f*, of the first perspective diameter *fb*, draw m*f*, cutting the second in *i*; through the other extremity *b* draw m*b*, cutting the second diameter in e.

Perspective.



Having now obtained the second diameter *ei*, we may find the third from the second, the same as the second was found from the first; and so on, from one to another, till the whole are found.

For if the indefinite representations of any two lines intersect each other, and if the two radials be bisected, a line drawn from the vanishing point of the bisecting line, cutting the two indefinite representations, will intercept two parts between the points of section and the point where these indefinite representations cut each other, of which the originals will be equal.

PROPOSITION XXIII.—PROBLEM XVIII.

Given the Centre and Distance of the Picture, the Intersection and Inclination of an original Plane to the Plane of the Picture, to find the Vanishing Line of that Plane, and the Centre and Distance of the Vanishing Line.

Let A B, figure 2, be the given intersecting line of the original plane, and C the centre of the picture.

Draw C O parallel, and C S perpendicular, to A B; make C O equal to the distance of the picture. Draw O S, so that the angle O S C may be equal to the inclination of the original plane to the picture. Draw S D parallel to A B; then will S D be the vanishing line, S its centre, and O S its distance.

For, imagine the triangle O C S to be raised on the picture, so that O C may be perpendicular to it; then the point O will be the point of sight, and S D being parallel to A B, a plane passing through the line S D and the point O, will be the parallel of the original plane, passing through A B, and inclined to the picture in the angle O S C; therefore S D is the vanishing line, O S the distance of the vanishing line from the point of sight O, and S the centre of the said vanishing line.

PROPOSITION XXIV.—PROBLEM XIX.

Given the Centre and Distance of the Picture, and the Vanishing Line of a Plane, to find the Vanishing Point of Lines perpendicular to that Plane.

Let A B, figure 3, be the vanishing line given, and C the centre of the picture.

Through C draw A D perpendicular, and C O parallel, to A B. Make C O equal to the distance of the picture; join O A, and draw O D perpendicular to O A; then D will be the vanishing point required.

When the vanishing line A B passes through the centre of the picture, then C O will coincide with A B, and as O D is drawn perpendicular to C A, both A D and O D will be perpendicular to A B; or, A D and O D being parallel, the vanishing point D will be at an infinite distance. See figure 4.

In this case the representations of lines, perpendicular to the plane proposed, will all be perpendicular to their vanishing line A B. This is actually the case when we would represent perpendiculars to a plane perpendicular to the picture, or in a vertical picture, upon a plane perpendicular to the horizon.

Demonstration.—Figure 3. Imagine the triangle A O D to be turned round A D until it is perpendicular to the picture; then O will be brought into the point of sight; therefore the plane passing through O and A B, will be parallel to the original plane, and the line O D, passing through the point of sight O, will be perpendicular to it, and as O D meets the picture in O, O will be the vanishing point of all original lines parallel to O D, or perpendicular to the original plane.

PROPOSITION XXV.—PROBLEM XX.

Given the Centre and Distance of the Picture, and the Vanishing Point of a Line, to find the Vanishing Line of a Plane, perpendicular to the original of the Line whose Vanishing Point is given, and the Centre and Distance of the Vanishing Line.

Let C, fig. 3, be the centre of the picture, and D the vanishing point given.

Through C draw DA and CO perpendicular to DA, and make CO equal to the distance of the picture: draw DO and OA perpendicular to DO; and, lastly, draw AB parallel to CO; then AB is the vanishing line required, and A its centre.

This construction here is the reverse of that in the preceding Problem, therefore the same observations apply here, and the same demonstration as in the Problem alluded to.

PROPOSITION XXVI.—PROBLEM XXI.

Given the Centre and Distance of the Picture, and the Vanishing Line of a Plane, through a given Point, to draw the Vanishing Line of another Plane, perpendicular to the Plane whose Vanishing Line is given, and to find the Centre and Distance of that Vanishing Line.

Let C, figure 4, be the centre of the picture, and AB the given vanishing line.

Find the vanishing point D of a line perpendicular to a plane whose vanishing line is AB, by Problem XIX; join DE, and draw CI perpendicular to DE, cutting DE in F; then DE is the vanishing line, and F its centre.

Its distance may be thus found; let CO, parallel to AB, be the distance of the picture; from D, as a centre with the radius DO, describe an arc, cutting CI at I; then FI is the distance of the vanishing line DE.

Demonstration.—Because the plane, whose vanishing line was required, is perpendicular to the other plane, its vanishing line must pass through the point D of lines perpendicular to that other plane; but as this vanishing line

must also pass through the point E, DE will be the vanishing line required; and, because a line drawn through the centre of the picture, perpendicular to a vanishing line, gives by its intersection the centre of that vanishing line; the point F is the centre of the vanishing line D E. The rest will be evident by turning up the triangle D A O perpendicular to the plane of the picture, then turning the triangle D I F round D E, until G falls upon O, then D G will coincide with D O.

Corollary 1. -If F C be produced till it meet the vanishing line given in the point B, B will be the vanishing point of lines perpendicular to the original plane of the vanishing line D E: for that vanishing point is in the line F C, by the construction of Proposition X. and it is in the vanishing line given by the demonstration of the present Proposition.

Corol. 2.—If the vanishing lines A B and D E meet in G, the points B, D, and G, will be the vanishing points of the three plane angles forming the solid angle of a cube; these planes being perpendicular to each other, and if D B be joined, B G, G D, and D B will be the vanishing lines of the three planes that contain that solid angle.

Corol. 3.—The distance of the vanishing line D G is also equal to the line F I; the point I being in the semi-circumference described upon D G as a diameter.

Corol. 4.—In the construction of the vanishing lines forming the solid angle, when the point of sight is found for each vanishing line, and the radials of the common intersections of the planes drawn, every two radials at the point of sight will be at right angles to each other, and every two of these radials, which terminate in the intersection of two vanishing lines, will be equal to each other. Hence in every two vanishing lines, if the centre and direct radial be drawn in the one, the direct radial can be found in the other, for the point of sight in this other will be in the circumference of a circle described from the intersection of the two vanishing lines, with a radius equal to the radial joining that intersection and the point of sight given.

Thus let G B and G D be the vanishing lines of two planes, and let A and F be their centres, and let H be the point of sight for the vanishing line G B. Draw F I perpendicular to G D; from the centre G, with the radius G H, describe an arc, cutting F I in I; then F I will be the direct radial.

Corol. 5.—If the point of position of the eye for each of two of the vanishing lines be found, the third will also be found; for it must be in the intersection of two circles described from the two vanishing points of the third vanishing line, with radii which are respectively equal to the two adjacent radials.

Corol. 6.—The length of any direct radial is a mean proportion between the segments of the vanishing line, on each side of the centre; because the plane angle, formed at the eye, is a right angle; and hence, as before observed, if we draw the perpendicular from the centre of the vanishing line, and describe a semicircle on the said line, the point where it intersects the perpendicular will be the point of sight.

PROPOSITION XXVII.—PROBLEM XXII.

Given the Centre and Distance of the Picture, and the Vanishing Point of the common Intersection of two Planes, inclined to each other in a given Angle, and the Vanishing Line of one of them, to find the Vanishing Line of the other.

Let C, figure 5, be the centre of the picture, B G the given vanishing line of one of the planes, and B the vanishing point of their common section, and H the angle of their inclination to one another.

Find the vanishing line G D of planes perpendicular to the lines whose vanishing point is B, (by Proposition XXV.) and let that vanishing line cut the vanishing line given in G. In G D find the vanishing point E of lines, making the given angle H with the lines, whose vanishing point is G; that is, in B C F, perpendicular to G F D, take F P equal to the distance of the vanishing line G D. If C O be parallel to G D, and equal to the distance of the picture, make F P equal to F O; join P G, and draw P E, meeting G D in E, so that the

angle GPE may be equal to H, and draw BE, then BE will be the vanishing line required.

Demonstration.—For imagine the triangle GPE to be turned on the line GD, so that the point P may fall in the perpendicular drawn from C to the plane of the paper or picture; then P will be the point of sight, and the apex of three imaginary planes, BPG, GPD, DPB, supposed to be raised on the vanishing lines BG, GD, DB. Then also the three planes, thus supposed to be raised, will be parallel to the three original planes which have BG, GD, DB, for their vanishing lines. Now the plane, whose vanishing line is DG, being perpendicular to the other two by construction, because it is perpendicular to their common section, whose vanishing point is B, will measure the inclination of these two other planes; therefore, by joining BE, BE will be the vanishing line required.

PROPOSITION XXVIII.—PROBLEM XXIII.

Having the Centre of the Picture, the Vanishing Lines of two original contiguous Planes, and the Centre and direct Radial of one of the Vanishing Lines, to find the Centre and direct Radial of the other Vanishing Line.—The reader to supply the figure himself.

Let C be the centre of the picture, AB and BD the two vanishing lines, H the centre of the vanishing line, AB and HO its direct radial.

Draw CM perpendicular to BD, cutting BD at L; make BM equal to BO; that is, with the radius BO describe an arc, cutting CM at M: then L is the centre and LM the distance of the vanishing line LM.

PROPOSITION XXIX.—PROBLEM XXIV.

Given the Centre and Distance of the Picture, the Vanishing Line of a Plane, the Inclination of a Line to that Plane, and the Angle which the Seat of the Line upon that Plane makes with the Intersecting Line, to find the Vanishing Point of that Line.

Let C, figure 5, be the centre of the picture, BG the given vanishing line.

Find D, the vanishing point of lines perpendicular to planes whose vanishing line is BG, and let DC cut BG in S, which is the centre of the vanishing line BG: make SI equal to the distance of the vanishing line BG; that is, if CO, parallel to BG, be equal to the distance of the picture, make SI equal to SO. Draw IK parallel to BG; and make the angle KIG equal to the angle which the seat of the line makes with the intersection. Join DG. Find the centre F and distance FP of the vanishing line DG; that is, draw PF perpendicular to DG, cutting DG in F; make GP equal to GI; and draw PE, meeting DG in E, so that the angle GPE may be equal to the inclination of the line to the plane, then E will be the vanishing point of the line required.

This construction is evident from the foregoing demonstration, and more particularly from the last.

When the vanishing line BG passes through the centre of the picture, the original plane and that of the picture will be perpendicular to each other. In this case the vanishing point D will be infinitely distant from the centre of the picture, and consequently the vanishing line DG will be perpendicular to the vanishing line BG; and because S and C are supposed to coincide, the points F and G will also coincide: the construction will, therefore, be simplified as follows:—

Draw CI, fig. 7, perpendicular to BG; make CI equal to the distance of the picture. Draw IK parallel to BG, and make the angle KIG equal to the angle which the seat of the line makes with the intersecting line. Draw DG perpendicular to BG; make GP equal to GI, and draw PE, meeting DG in E, so that the angle GPE may be equal to the inclination of the line to the plane; then E will be the vanishing point of the line required.

PROPOSITION XXX.—PROBLEM XXV.

Given the Vanishing Line of a Plane, the Centre and Distance of the Picture, the finite and indefinite Representations of two Lines in that Plane; from a given Point in the indefinite Representation, to cut off a Part, which shall represent a Line equal to the Line represented by the finite Representation.

Let V L, figure 8, be the vanishing line, C the centre of the picture, *ab* the finite representation of a line, and *c* L the indefinite representation of another; it is required to cut off from *c* a portion of the line *c* L, of which the original shall be equal to the original of the line represented by *a b.*

Draw C O perpendicular to V L, intersecting V L in the point S, the centre of the vanishing line. Draw C E parallel to V L, and make C E equal to the distance of the picture. Join S E, and make S O equal to S E. Join O V and O L. Draw the radial O*m,* bisecting the angle V O L.

Draw the straight line b d parallel to V L. From the vanishing point m, and through the points *a* and *b,* draw the straight lines m a, m b, meeting the line b d in the points a and b; also, from the same vanishing point m, and through the point *c,* draw the straight line m c, meeting B D in C. In b d, make the line c d to a b, as the original of *c d* is to the original of *a b.* Draw the straight line d m, intersecting *c* L in *d,* and *c d* is the line required.

SCHOLIUM.

This Problem is useful in the representation of solids; for it sometimes happens, after we have finished the representation of one plane, that we have another to represent, and having already determined the vanishing line from the circumstances of the Problem, and having the centre and distance of the picture, which were necessary in the representation of that plane, we have the same data still, and consequently we may, by these means, represent lines, of which the originals may have any ratio to each other, and thus find the representation of any figure: in short, perform any of the foregoing Problems.

Part II.—PERSPECTIVE.

Of the Representation of Solids.

All objects whatever, that are formed by art, come under the denomination of some geometrical solid, as a prism, a pyramid, a cylinder, a cone, a sphere, &c. Thus the body of a house is generally a rectangular prism, and the roof may either be a right triangular prism, as in pediment roofs, or the frustum of a pyramid, as in hip-roofs. Or, if the body of a building be a cylinder, the roof may either be a cone or a segment or zone of a sphere, as in domes. The surfaces of these solids are, therefore, triangles, rectangles, circles, &c. Therefore to represent any object of Cabinet Furniture, or building, it will be necessary to represent the several kinds of geometrical solids; but more particularly the rectangular parallelopiped. And as most objects stand perpendicular to the horizon, they will be represented as if they stood upon a plane perpendicular to the picture. A cube, or rectangular prism, is perpendicular to the horizon when one of its faces coincides with a horizontal plane; a right cylinder, or cone, is said to stand perpendicular to the horizon when the axis is perpendicular to the horizon; therefore in representing such objects, the axis will be parallel to the picture, and will therefore be represented by straight lines perpendicular to the vanishing line.

Having treated of the representations of various kinds of plane figures, nothing now remains to be done in order to represent a solid bounded by a plane figure, but to combine the faces according to their angles of inclination.

To enable the student to execute this part in the most general manner, he has only to know from *having given the centre and distance of the picture, the angle of inclination of two planes, the vanishing point of their common*

*section, and the vanishing line of one of the planes, in order to be able to find the vanishing line of the other, as also its centre and distance.**

If he has studied the preceding propositions with care, he is already in possession of the principle for accomplishing this object: but as this generality in the method of representing solids is seldom required in perspective, and less perhaps by the designer of cabinet work than by the architect or builder, we shall here trace the principle as applied to a parallelopiped to that of a rectangular prism, according to the various positions of the faces of the solid.

We must consider, that as a rectangular object is bounded by six faces, which are plane surfaces, and since every plane has its parallel, every two planes may have a vanishing line, since the six faces may be inclined to the picture.

The number of vanishing lines, and the number of vanishing points, can never exceed three of each kind.

Moreover, since the solid cannot have more than two of its faces parallel to the picture, it cannot have fewer vanishing lines than two, nor fewer vanishing points than one, and in this case, where two of the planes are parallel to the picture, the other four planes are perpendicular to the same; therefore, the vanishing line of each pair of these four planes, must pass through the centre of the picture.

When two of the faces of the solid are parallel to the picture, the other four faces being perpendicular, have their four edges also perpendicular to the picture; therefore, these four edges, being parallel to the intersection of the two planes, which passes through the eye parallel to the four planes perpendicular to the picture, have only one vanishing point in the centre of the picture.

* It may be proper to mention in this note, a simplification of a proposition which leads to the solution of the above Problem, perhaps, in a more simple manner. The proposition which we allude to is this:—"*Given the Centre and Distance of the Picture, and the Vanishing Point of a Line, in a Plane perpendicular to the Picture, to find the Vanishing Point of another Line in that Plane, perpendicular to the Line whose Vanishing Point is given.*"

The remaining two faces, being parallel to the picture, are represented by equal and similar rectangles. In this case, since a line which is parallel to the picture, has its representation parallel to the vanishing line of the plane, passing through the original line; the eight edges of the solid, which are parallel to the picture, are in the four perpendicular planes to the picture therefore, the representations of these eight lines are parallel to the vanishing lines of these four planes.

When four of the edges of the solid are parallel to the picture, and perpendicular to the horizon, and the planes between these edges inclined to the picture, the remaining two planes are perpendicular to the plane of the picture, and parallel to the horizon, but the edges of these two planes are inclined to the picture; therefore, these eight edges being thus inclined, and in planes perpendicular to the picture, have two vanishing points in the vanishing line of the two planes which are perpendicular to the picture, and therefore in the horizontal line; and as straight lines, perpendicular to a plane which is perpendicular to the picture, are represented by straight lines perpendicular to the vanishing line of that plane, the representations of these four edges are perpendicular to the vanishing line of the horizon.

Having thus traced the different positions of the representations of lines, from the different positions of the faces of the rectangular prism to the plane of the picture; it will be of the greatest use to trace the same positions of representation from the angles of inclination of the planes of the solid, which are all right angles, and from the properties of their vanishing lines, in order to trace the principle through the various stages of position.

When the centre of the picture falls in the centre of the given vanishing line, we shall find the vanishing point of the four lines perpendicular to the planes, of which the vanishing line is given at an infinite distance, and in a line passing through the centre of the picture perpendicularly to the vanishbishing line given of the two planes, which are perpendicular to the plane of the picture.

This indicates that the representations of the four lines are perpendicular to the vanishing line.

In this case the edges of the two planes, of which the vanishing line is given, may either have one or two vanishing points; if they have two vanishing points, four of the edges of the solid will be parallel to the picture, and the faces terminated by these edges inclined to the picture.

In the case where there are three vanishing lines, which will form a triangle, and the three vanishing points will be in the vertices of the triangles, and consequently there will be two vanishing points in each vanishing line.

Since the vanishing point of lines perpendicular to a plane, of which the vanishing line is given, always passes through the centre of the picture; therefore, when one of the vanishing lines is given, and the centre of the picture is in the centre of the vanishing line, the vanishing point of these lines will be in the perpendicular to the vanishing line, at an infinite distance from the centre of the picture; the other two vanishing lines, which join the vanishing point, and the two vanishing points in the vanishing line given, must be also perpendicular to the same vanishing line given.

For in performing this operation, we at first draw a straight line from the centre of the picture, perpendicular to the vanishing line given, and set the distance of the picture from its centre, upon the perpendicular; then the other extremity of this distance is the point of sight.

When this is done, we draw the radial which joins the vanishing point of the common section of the two original planes and the point of sight, and from the point of sight we draw another radial perpendicular to the first, and consequently perpendicular to the vanishing line given, and then a line through the vanishing point found by the second radial perpendicular to the vanishing lines; and this last perpendicular will be the vanishing line of a plane perpendicular to the line of which the vanishing point is given, and the point of intersection of the two vanishing lines, will be the centre of this last vanishing line, and the length of the last radial is its distance; so that the

point of sight for this new vanishing line will be in the first vanishing line, as the two vanishing lines intersect each other at right angles.

We now proceed to set off the angle of inclination of the two planes, at this new point of sight, for the second vanishing line, so that the first vanishing line may be one side of the angle; and by producing the line forming the other side of the angle to meet the second vanishing line, we shall have the vanishing point of all those lines which are perpendicular to the common section of the two original planes, and which form their angle of inclination.

This circumstance will enable the artist to represent the lid of a box at any angle of inclination with the top; to represent a ladder in any position to the horizon, or to represent the rafters of a building perpendicularly to the wall-plates, and making a given angle with the horizon, or top of the building.

But if all the faces of a solid are planes, which are at right angles to each other, it will not be necessary to find more vanishing lines than that which is already given; for in this case, though we may have a second vanishing line, it would not be used in the operation; for the angle of inclination of the planes being a right angle, and when this right angle is set off from the second point of sight, so that the perpendicular radial, which is part of the first vanishing line, may form one side of the angle, the other side of the angle must therefore be parallel to the second vanishing line, and consequently perpendicular to the first. This therefore indicates that the vanishing point is at an infinite distance, and therefore the representation of all lines, perpendicular to the plane of which the vanishing line is given, are also perpendicular to the same vanishing line. So that in representing a rectangular solid, which can have only three vanishing points at most, and of which one of the vanishing points is not in the centre of the picture, two of them must be in the vanishing line given; and the third series of lines, which represent the edges, are perpendicular to the said vanishing line.

These preliminary observations will be evident in the examples of representing solids in perspective.

Observation,

With respect to general methods of practice in the representation of objects comprehended under the forms of rectangular parallelopipeds, or rectangular prisms, deduced from the immediately preceding observations.—

The first consideration is, to fix on the point of view; this will determine the centre and distance of the picture; therefore, in what follows, we shall always suppose the centre and distance of the picture to be given, the determination of these will therefore form no part of the operation in representing rectangular objects in perspective.

There are two positions, in respect to the picture, of representing rectangular bodies, commonly called rectangular parallelopipeds, or rectangular prisms; the one is, by considering two of the faces parallel to the picture; and consequently, the other four perpendicular to the same. Hence, in this case, the vanishing point of the four parallel lines, in the meeting of the four planes, which planes being perpendicular to the plane of the picture, will be in the centre of the picture; the outlines of the figures representing the other two planes, which are parallel to the picture, are rectangles, which have their sides parallel and perpendicular to the vanishing line of the four planes which are perpendicular to the picture.

The common sections of those two planes, of which the vanishing line is given, and of the two planes which are parallel to the picture, are represented by straight lines parallel to the vanishing line, and consequently, the other two edges of the planes, which are parallel to the picture, are represented by lines which are perpendicular to the vanishing line.

The other position of the solid is, by considering two of the planes to be perpendicular to the picture, and each pair of the other four inclined. In representing such a solid, only one vanishing line, as we have already seen, will be necessary, and this vanishing line will be that of the two faces of the solid which are perpendicular to the picture, therefore each vanishing point will be the vanishing point of four lines, viz. those of the opposite parallel

planes. Therefore, eight of the edges or arrises of the solid have their vanishing points in the vanishing line; because the vanishing line is the intersection of a plane with the picture passing through the eye, parallel to the two perpendicular planes. The arrises of the four planes, which are inclined to the picture, being perpendicular to the other two planes, which are perpendicular to the picture, are therefore parallel to the picture, and are consequently represented by lines which are perpendicular to the vanishing line.

There are, therefore, three positions of the object in respect of the picture: one is, when all the sides are inclined to the picture; a second is, when two parallel faces are perpendicular to the picture; and the third, when two parallel faces are parallel, and consequently the other four perpendicular to the picture.

The first of these is called *the triple inclined position,* or simply the *inclined position of the picture;* the picture being inclined to all the three pairs of parallel planes, or parallel faces of the object. The second is called the *single perpendicular position of the object,* or only *the perpendicular* position, the picture being perpendicular only to one pair of parallel sides of the object. The third is called the *parallel position,* or *double perpendicular position of the picture,* the picture being parallel to one pair only of the faces of the object, or perpendicular to two pair of faces.

The art of representing rectangular bodies having one pair of its faces parallel to the picture, has been denominated *parallel perspective.*

In all positions of the picture, its centre and distance must always be a part of the data; and where the object is inclined, the inclination of one of its sides to the plane of the picture must be given, or some other equivalent.

Practice in representing a Rectangular Object according to the Triple Inclined Position.

As the position of the object to the picture depends upon choice, to save a great deal of useless trouble, it is customary to assume the vanishing line of

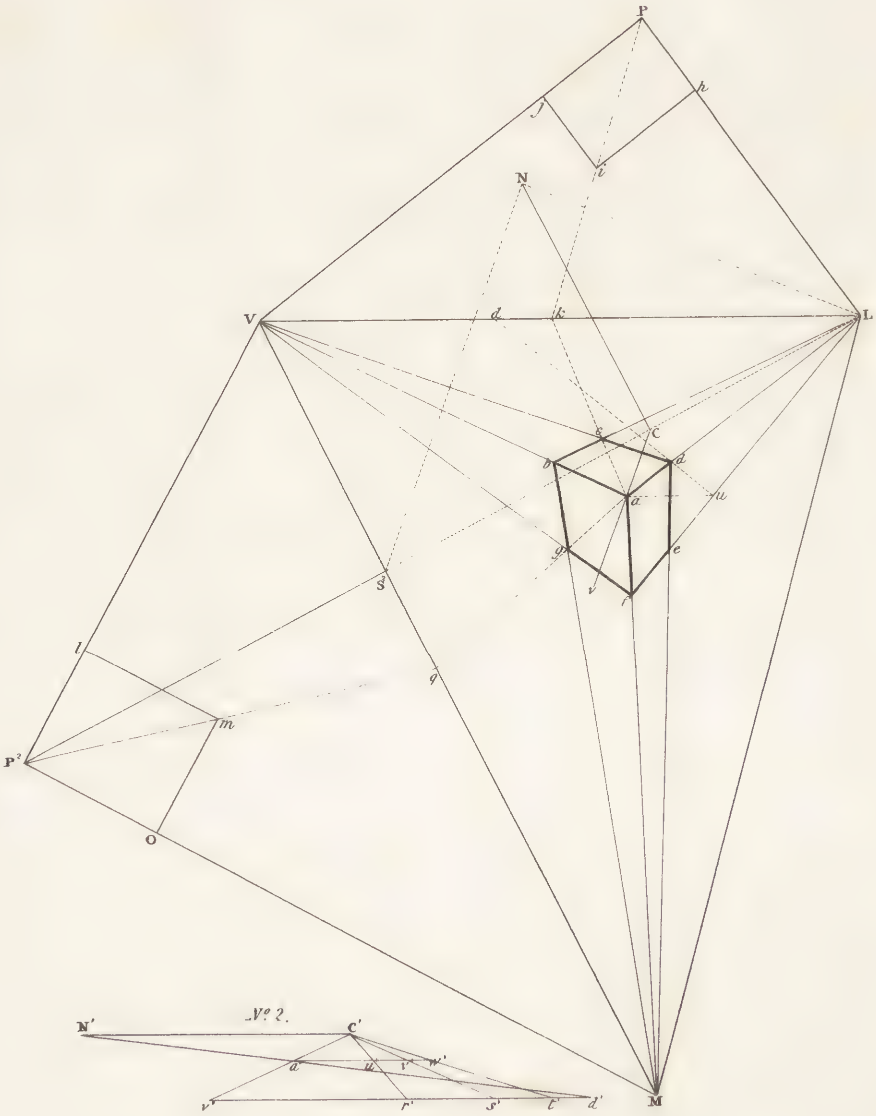
one pair of its parallel faces, and the centre of the picture, as also to assume the vanishing point of a pair of sides of the rectangles of these two parallel faces of the object; this assumed point must therefore be in the assumed vanishing line; for the vanishing points of all lines in the same plane are in the vanishing line of that plane. This vanishing point is, therefore, the vanishing point of the line of concourse of two faces of the object that are reciprocally perpendicular to each other, viz. of one of the faces of which its vanishing line is assumed, and one of the four perpendicular faces to that of which the vanishing line was assumed.

We have now given the centre and distance of the picture, and the vanishing line of a plane, to find the vanishing point of lines perpendicular to that plane; and this being found with the vanishing point of the line of concourse of two of the faces, will give two of the vertices of the triangle formed by the three vanishing lines of the three pair of parallel faces of the object.

In order to find the third vertex of the vanishing triangle, find the point of position of the eye to the vanishing line; join this point of position to the assumed vanishing point, and from the point of position draw a radial perpendicular to the line thus joined, and the vanishing point made by this radial is the vanishing point of the vertex of the remaining angle of the vanishing triangle. These three vertices are the vanishing points of the twelve arrises or lines of concourse of the faces of the solid, there being four parallel lines for each of the three vanishing points.

Therefore, by drawing a straight line from each of the two vanishing points in the vanishing line given, to the third vanishing point found, we shall have the three vanishing lines; two of these are, however, only necessary.

But in order to represent the three faces which constitute the solid angle next to the eye of the observer, it will be necessary to find the centre and distance of one of the last drawn vanishing lines, which being done, find the representation of each rectangle, of which the vanishing line, its centre and distance, as well as the vanishing points of the sides of each, are both now given. The representation of the remaining face or rectangle will be found



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by only drawing lines from the ends of the lines in the adjacent edges of the trapeziums, which represent the two first rectangles to the vanishing points of this last rectangle.

To represent or find the image of a rectangular solid, its position in respect of the eye, and the picture being determined; by knowing the distance of the eye and the distance of the vertex of the nearest solid angle, each from the picture, and having given in position in the plane of the picture, its centre and the vanishing line of one of the faces.—This single example very nearly embraces the whole of Perspective; we shall therefore, in order to be distinct, number the propositions.

No. 1.—We have given the distance of the picture, C its centre, L the vanishing point of a line; to find the vanishing line of a plane, perpendicular to the line of which the vanishing point L is given. (See Prop. XXV.)

Through the points L and C draw the straight line LS^2, and CN perpendicular to LS^2. Make CN equal to the distance of the picture, and join LN. Draw NS^2 perpendicular to LN, and through S^2 draw VM perpendicular to LS^2, and VM is the vanishing line here required.

In this part of the operation we have also found S^2 the centre, and a line S^2N equal to the distance of the vanishing line VM, as also V the vanishing point of the line of intersection of the planes, of which VM and VL are the vanishing lines.

This vanishing line being now found, will be enumerated among the data in the following Problem, as one of the given parts.

No. 2.—Given in the picture in respect of two lines in a plane, making a given angle with each other. VM the vanishing line of their plane, S^2 its centre, and a line S^2N equal to its distance, to find the vanishing point of the other line.

Draw S^2P^2 perpendicular to VM, (or, since CS^2 is already perpendicular to VM, prolong, if necessary, CS^2 to P^2.) Join VP^2, and make the angle VP^2M equal to the angle which the two lines make with each other; and as this angle in the present case is a right angle, draw P^2M perpendicular to VP^2, and M is the point here required.

This vanishing point being found, it will make a part of the data of the following Problem.

No. 3.—Given in the picture of two straight lines in a plane, their vanishing points L and M, to find the vanishing line of the plane.

Join the points L and M, and LM will evidently be the vanishing line required; for the vanishing points of all lines in the same plane are in the vanishing line of that plane.

By these operations, one grand Problem, which embraces the whole, is solved. The Problem which we now allude to is as follows:—

Given with respect to two planes, making a given angle with each other, the centre and distance of the picture, the vanishing line of one of the planes, and the vanishing point of their line of concourse, to find the vanishing line of the other plane.

This Problem has been solved in finding the vanishing line LM, therefore VL and VM are the vanishing lines of the two planes of the solid, and V the vanishing point of their line of concourse, or common section.

But in the solution of this Problem we found VM the vanishing line of a plane perpendicular to the line of concourse of the two planes, of which the vanishing lines are VL, LM. But since in each solid angle of a rectangular solid, any one of the three faces is perpendicular to the line of concourse of the other two, therefore VM is the vanishing line of the third plane.

The object being rectangular, supersedes the necessity of finding the third vanishing line. In consequence of VM being the vanishing line of the third plane, V and M are the vanishing points of the remaining two arrises which are common to the third plane and each of the two first.

In these operations we have found the radials P^2V and P^2M of the sides of the rectangles in the two planes of the solid, which have VM for their vanishing line; we must now find the radials of the plane which have VL for their vanishing line. We shall, therefore, proceed to enumerate the Problem.

No. 4.—Given in the picture with respect to a rectangle, the vanishing points of the sides, and the lengths VP^2 and LN of the two radials, to find the radials in position to the vanishing line VL.

From the point L, as a centre with the distance LN, describe an arc; and from the point V, as a centre, with the distance VP^2, describe another arc, intersecting the former in P. Join PV and PL, then PV and PL are the two radials which were to be found.

It is evident, that in the triangle formed by the three vanishing lines, a line drawn from any one of the vertices, through the centre of the picture, will be perpendicular to the opposite side of the triangle, and this can very easily be proved from the geometry of solids.

For if a straight line be drawn from the vertex of any angle of a triangle, perpendicular to the opposite side, dividing this side into two segments; and if a semicircle be described on the perpendicular as a diameter, and if the mean proportional between the segments be applied as a chord in the semicircular arc, so that the point of division may be one extremity of the chord, and if from the other extremity of the chord a perpendicular be let fall upon the diameter, a straight line drawn from any one of the three vertices, through the foot of the perpendicular, will be perpendicular to the opposite side of the triangle.

Hence, with respect to a plane, and a line perpendicular to that plane, if we have the centre of the picture, the vanishing line of the plane, and the vanishing point of the line, a straight line drawn through the vanishing point of the line, and through the centre of the picture, will meet or intersect the vanishing line in its centre.

Having thus obtained the three vanishing lines of the planes of the nearest solid angle, we shall now proceed first to find the image of the vertex.

No. 5. –Given the distances from the eye, and from a point each to the plane of the picture, and in this plane, its centre, and the seat of the point, to find the image of the point.

Join C*v*, and the representation of the point will be in the line C*v*; and here we might proceed with the operation, but to prevent the confusion of lines which would arise in the course of so many operations, the reader is referred to the separate Diagram, No. 2; where, by first drawing C′*v*′, and making C′*v*′ equal to C*v* in the figure, he may proceed with No. 2 as follows: draw C′N′ and *v*′*d*′ parallel to each other, making any convenient angle with *v*′C′. Take C′N′ equal to the distance of the picture or any part of it, and take *v*′*d*′ equal to the distance of the point from its seat, or the same part of this distance that C′N′ is of the distance of the picture. As we have sufficient room on the surface we have to draw upon for this subsidiary operation, we shall employ the whole distance, therefore draw N′*d*′, intersecting *v*′C′ in *a*′. Transfer the distance *v*′*a*′ to the figure of the solid, to be represented from *v* to *a* in the straight line *v*C.

We have now the image of the vertex of the nearest solid angle, and by joining the point now found with each of the vertices V, L, M of the triangle formed by the vanishing lines, we shall have *a*L, *a*V, and *a*M, the indefinite images of the three lines of concourse in the plane of the picture.

We have, therefore, all the vanishing lines, the vanishing points, and the radials of these points for two of the vanishing lines; as also the image of the vertex of the nearest solid angle, and therefore we have for each of two adjacent rectangular faces of the solid, the vanishing line of the indefinite images of the two sides of the rectangle of that face; but for want of an intersecting line, we cannot cut off from the two indefinite images a portion from each, so that the original of the parts may be the length of the arrises or line of concourse of the adjacent faces of the solid.

We must, therefore, proceed to find an intersecting line, or line on which the measures may be applied. There is no occasion, however, to find the real intersecting lines, for if we have the indefinite image of a line perpendicular to the picture, the intersecting point of the line, and the image of a point in this line, we can find such measures as may be applied upon a line drawn through the indefinite image of the point, parallel to the vanishing line; and as would be found by the real intersecting line in a more convenient manner, from this consideration that the whole distance between a plane passing through the eye parallel to the picture, and a point in space is to the distance between the eye and the picture, as the length of a line parallel to the picture passing through that point is to the length of a line passing through its image parallel to the vanishing line. Therefore if the line which passes through the original point be equal to any one of the three dimensions of the solid, the length of the line found, as the fourth term of the proportion, will be the length of the side to be applied on the parallel passing through the image of the point.

To do what has now been explained, is equivalent to finding the image of a similar solid and similarly situated, having the vertex of its nearest solid angle in the point *a*, from dimensions which would be those found by the proportion just stated. Or by calling the perpendicular distance between the eye and a plane passing through the vertex of the nearest solid angle parallel to the picture, the entire distance, and calling any line from the intersecting point before the picture *an*

entire indefinite line; the distance between the intersecting and vanishing points, the *entire indefinite image;* and moreover calling that part of the entire indefinite image of a straight line between the image of a point and the vanishing point, the *indefinite part of the entire image* from the image of the point.

Then any dimension of the solid proposed to be delineated, and the corresponding dimensions of the similar solid which touches the picture, will be to one another in the ratio of the entire indefinite image of the line passing through the vertex of the nearest solid angle perpendicularly to the picture, and the indefinite part from the image of the vertex; that is, in the ratio of C*v* to C*a*.

Let the lengths of the three arrises between every two faces of the solid angle be respectively equal to the three lines R′, S′, T′; transfer the three lengths R′, S′, T′ to No. 1, upon the line $v'\,d'$ respectively, from v' to r', from v' to s', and from v' to t'. Draw $a'\,w'$ parallel to $v'\,d'$, and join C$'r'$, C$'s'$, C$'w'$, intersecting $a'\,w'$ in the points u', v', w', then the lengths corresponding to R′, S′, T are respectively $a'u'$, $a'v'$, and $a'w'$.

These are the dimensions of the body which answer to the intersecting line in the figure, passing through a parallel to the vanishing line.

Hence we may suppose, that $a'u'$ is the length of the arris to be represented in the line *a*L, $a'v'$ the length of the arris to be represented in the line *a*V, and $a'w'$ the length of the arris to be represented in the line AM.

No. 6.—Given in the picture of two lines meeting in a point, one finite, and the other indefinite; the two representations and their radials to cut off a part from the indefinite image, so that the originals of the finite images may be to one another in a given ratio.

In the radials PL and PV, from P, the point of position of the eye to the vanishing line VL, make P*h* and P*j* respectively equal to the lines R′, S′, or in any ratio of these lines, as $\frac{1}{2}$, $\frac{1}{3}$, $\frac{1}{4}$, &c. and complete the rectangle P*hij*. Draw the diagonal P*i*, and prolong it to meet the vanishing line VL in *k;* find *q* in the same manner with regard to the vanishing line VM; that is, make P^2l, P^2o in the ratio of the lines S′ and T′; complete the rectangle P^2lmo, and draw thediagonal P^2m, and produce it to *q*.

In the vanishing line LV, make Ld' equal to the radial LP; and through *a* draw *au* parallel to VL. Make *au* equal to $a'u'$ in the subsidiary figure; join $d'u$, intersecting *a*L in *d;* join *d*V and *ak*, intersecting each other in *c;* join L*c*, and produce L*c* to meet *a*V in the point *b;* join *b*M and *aq*, intersecting each other in *g;* and lastly, join V*g*, and prolong V*g* to meet *a*M in *f;* then *abcefg* is the rectangular prism required.

The perspective representation of any parallelopiped would have been found in the same manner, by finding the vanishing lines so as to answer the inclination of the planes, instead of the right angles in the construction.

PRACTICAL EXAMPLES OF SOLIDS.

The diagram 5, plate XII, exhibits the representation of a cube.

Having by the preceding principles found *a b*, *a c*, the perspective representations of the two front lines of the base of the cube; prolong one of them as *a b*, to meet the intersecting line P Q in the point H. Draw H I perpendicular to P Q and make H I equal to the height of the solid, that is equal to the side of the cube, and as V is the vanishing point of *a b*, V will also be the vanishing point of the opposite and parallel side: therefore join H V, and *a d* and *b e* perpendicular to P Q, meeting I V in the points *d* and *e*. Again, because L is the vanishing point of the side *a c*, L will also be the vanishing point of the side opposite and parallel to *a c*, therefore join *a* L and draw *c g* parallel to H I meeting *d* L in *g*. Draw *g* V and *e* L meeting each other in the point *f*, then *b a c g f e* will be the representation of the solid.

Figure 6, plate XII, gives the representations of two rectangular parallelopipedons attached to each other, the one being higher than the level of the vanishing line, and the other lower.

Having put the front lines of the bases into perspective as before, prolong one side of each base to the intersecting line, and draw a perpendicular from each intersecting point to the intersecting line: call each of these perpendiculars a line of heights. Set the height of each solid upon its respective line of heights, and complete the apparent sides and the top of each solid as in figure 5, and we shall have the representation of both solids thus attached.

These solids may represent two parts of a building at different heights, as is frequently the case in complex objects, or it may represent a piece of furniture of the same forms.

Fig. 9, represents a kind of forum building of the most simple construction; the walls are all rectangular parallelopipedons, and consequently represented as in figures 5 and 6.

The main building, as well as the barn and other offices, are roofed in the same manner with gables, and all at the same angle of inclination, therefore all the gables which stand parallel will have the same two vanishing points; and as the walls are at right angles to one another, and perpendicular to the horizon, the vanishing points of the gables, which are in one set of parallel planes, will have their vanishing points in the line drawn through the vanishing point of the level lines of these walls, perpendicular to the vanishing line, and those in the other series of parallel walls will have their vanishing points in a line drawn through the vanishing point of the level lines of these walls, perpendicular to the vanishing line.

Let V L be the vanishing line, and P Q the intersecting line of the horizontal plane, upon which the objects are supposed to be placed, also let C be the centre of the picture, and C O its distance, O being the place of the eye.

To find the vanishing points of those gables which are in the planes that have their vanishing lines on the right hand of the centre of the picture. Take the distance between the vanishing point L and the eye at O, and transfer this distance upon the vanishing line V L: from the point of distance make an angle with V L equal to the inclination at the plane of the roof to the plain of the horizon, and the point where the other side of this angle meets the vertical vanishing line, passing through L, will be the vanishing point of one side of the roof.

By setting the distance between the vanishing point L, and the vanishing point now found above L, downwards from L upon the vertical vanishing line passing through L, we shall have the vanishing point of the remote lines of all the gables in the planes of which their vanishing line is the perpendicular to V L, passing through the vanishing point L.

Again, transfer the distance V O of the vanishing point V, and the eye O upon the vanishing line V L, and from this point of distance make an angle with the vanishing line L V, equal to the angle which the sloping sides of the pediments in the walls, at right angles, to the former, makes with the horizon, and let the other side of this angle meet the perpendicular to V L, passing through the point V; and as the angle thus constructed, may be upon either side of the vanishing line V L, the point where the side of this angle meets the perpendicular drawn through V to the line V L, will be above or below the point V accordingly, so that upon whichever side of V this happens, the other vanishing point must be set upon the contrary side.

By means of the two vanishing points found on the right hand, we shall have the vanishing point of all the gables on the right hand, and by means of the two vanishing points found on the left hand, we shall have the vanishing points of all the gables on the left hand, of which the two sloping sides of each, and the sloping sides of every two, make the same angle with the horizon.

The roof of the pent-house on the right hand has only one sloping side; this sort of roof is called a shed roof. As the plane of the two ends of this roof of the two sloping walls are parallel to the planes of the gables of the dwelling-house, the vanishing point of the sloping top will be in the vertical vanishing line drawn through L; the vanishing point of this sloping side is found exactly in the same manner as either of the sloping sides of the roof of the dwelling-house, or of the other gables which have the same inclination.

The upper vanishing point in the vertical vanishing line, is the vanishing point of the two sloping sides of the visible plane of the roof of the dwelling-house, and of the small triangular front which terminates the door over the stable; and the vanishing point at the same distance below L, is the vanish-

ing point of the two sloping edges of the side of the roof which is not visible, also the vanishing point of the other sloping line which terminates the door over the stable.

The vanishing point of the two equal sloping lines which terminate the gable of the stable, are in the vertical vanishing line passing through v, equally distant from v.

As two of the planes of the chimney shaft of the dwelling-house are parallel to the gable of the same house, these planes will be intersected by the inclined plane of the roof; and the line of intersection, and the plane of the horizon, will form the same angle as each of the two sloping sides which terminate this inclined side of the roof, therefore the intersection of the visible planes of the chimney shaft, and inclined side of the roof, will have the same vanishing points as the two lines which terminate the visible inclined side of the roof.

As the vanishing points of all lines in the same plane are in the vanishing line of that plane, if the vanishing points of any two lines in any plane be given, the vanishing line of their plane will be found by drawing a straight line through the two vanishing points.

To apply this observation to the present purpose, the vanishing point v of the line which terminates the top of the wall, is also the vanishing point of a line in the visible inclined plane of the roof, and the vanishing point of the line which terminates this visible inclined side of the roof, and the visible gable, is therefore another vanishing point in the visible inclined plane of the roof; therefore as the inclined planes of the roofs run in two different directions, they will have two different vanishing lines. Let these two vanishing lines be found, and the point where they intersect each other will be the vanishing point of the common intersection of the two inclined planes, to which the two vanishing lines belong. This vanishing point will be the vanishing point of the visible side of the roof of the dormer, in the front over the stable, with the visible side of the roof of the stable.

PLATE XIV.

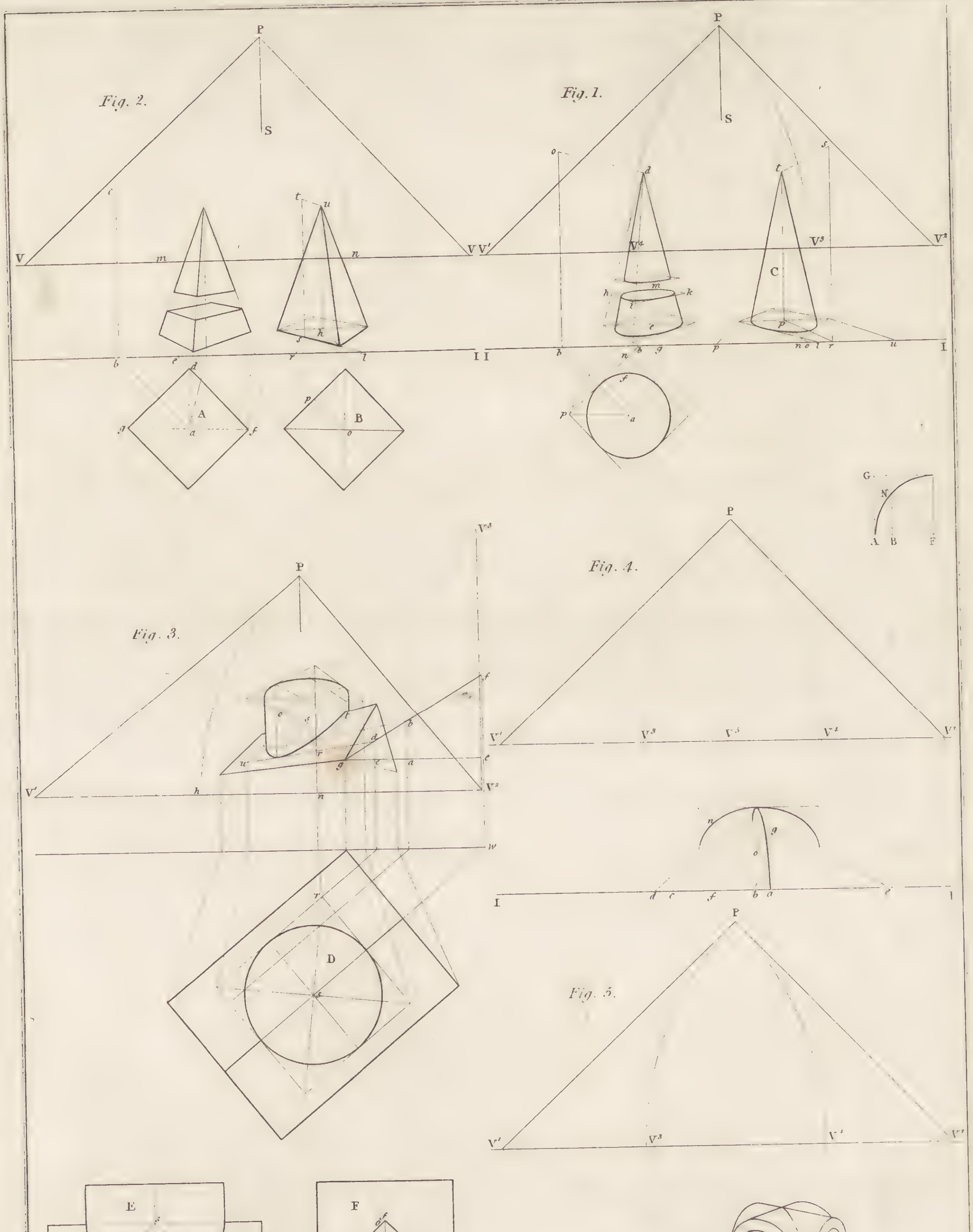
Fig. 1.—Shews the method of representing a cone, P being the point of sight, S the station point, $V^1 V^2$ the vanishing line, I I the intersecting line. In this diagram two cones are represented; that on the right hand is done by means of the plan, and that on the left by means of the measures applied upon the ground line.

The first of the representations is to find the perspective projection of the plan, and the perspective of the centre of the circle; from this point draw a perpendicular to the vanishing line, then the height of this perpendicular being found, we shall have the perspective representations of the axis; then join the upper extremity of this axis to each extremity of the curve of the ellipse, which represents the base of the cone, as a tangent, and these two tangents and the convex part of the curve intercepted between them, will be the perspective representation of the cone.

Fig. 2.—Exhibits the method of representing a pyramid operating in the same manner as in the cone. In this, as in the former examples of a cone, there are two representations of a pyramid, the one with and the other without the plan; the base is first represented, the centre of the base next, then the summit of the pyramid, then join this summit to the points of concourse of the sides of the trapezium representing the base, and we shall thus have the perspective representation required of the pyramid.

The representation of the summit of the pyramid, or that of the cone, may be found thus: Draw a straight line from any convenient point in the intersecting line perpendicular to the vanishing line, then upon this perpendicular set the height of the axis. Join the foot of the perpendicular to the foot of the axis, and prolong the line thus joined to meet the vanishing line. Join the upper extremity of the perpendicular end, and the point found in the vanishing line, and the line thus joined will cut the axis in the summit.

Fig. 3.—Exhibits the method of putting an isosceles roof in perspective intersected by a cylindrical wall. The vertical planes of the wall are here found by means of the plan: $V^1 V^2$ is the vanishing line of the horizontal planes; $V^2 V^3$ the vanishing line of the vertical parallel planes, two of which are the gables; V^3 is the vanishing point of one of the sloping sides, which terminate the top of each gable.



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wf perpendicular to the intersecting line is the height of the ridge line of the roof, the point *w* being found by producing the ridge line on the plan below. The line *gf* is the intersection of the plane of the roof with the plane of the picture. The circular base of the wall is here drawn on the plan. The circle on the plan is here supposed to be divided into eight equal parts; first into four by two diameters, each parallel to one of the sides of the plan of the building, the one being parallel to one side of this plan, and the other parallel to the other side of the same, and consequently these two diameters are at right angles to each other; then a square is circumscribed about the circle, so that the sides may be parallel to the plans of the sides of the wall, and the diagonals of the square being drawn will divide the circumference of the circle also into four equal parts: so that the whole will be divided into eight equal parts.

Through the point where one of the diagonals intersects the circumference, draw a line parallel to the side line, to meet the intersection or ground; the line thus drawn being in the visible plane of the roof. In the same visible plane of the roof draw a tangent to the circle parallel to the ridge line, to meet the same intersecting or ground line.

From these two points in the intersecting line draw perpendiculars to the vanishing line to meet the intersection *gf* of the visible side of the roof. From the points *b*, *d*, where these perpendiculars meet the intersection *gf* of the sloping visible side of the roof, draw lines to the vanishing point V^1. Also from each of the visible extremities of the side of the square next to the front in the visible side of the roof, draw a line to the station point to meet the intersecting line; then draw two lines perpendicular to the intersecting line, to intersect the line *du* in the points *r* and *u*.

From the points *r* and *u* draw lines to V^3 to meet the line drawn from *f* towards V^1 representing the ridge, and thus we have a trapezium, in which the portion of the ellipse which represents the intersection of the cylindric surface and the plane of the roof is inscribed. Draw the two diagonals *su* and *sr*, and draw a line from V^3 through *s* to meet the line *ur*, and this point in *ur* is one of the points through which the curve of the ellipse must pass; two other points are in the line representing the ridge, and two other points are in the diagonals *su* and *sr*, so that we have five points in the representation of the visible part of this intersection of the cylindric surface, and the plane of the roof. Draw a curve through these five points, and the representation of this intersection will be complete.

Then drawing the representation of the horizontal circle which terminates the top of the cylindric surface, and drawing the two vertical tangents to this circle, we shall have the representation of the visible part of the cylindric wall above the roof.

To give the most clear idea of this subject, the two elevations are given below at E and F, with the intersections of the principal points. To those who have a clear idea of the subject, these elevations may be dispensed with.

Fig. 4.—Exhibits the process of finding the perspective representation of the two diagonal ribs of a cylindric ground vault. This is found by applying the measures to the intersecting line.—Fig. 5, exhibits the perspective representation of a cylindric ground vault, the external and internal cylindric surfaces being both concentric cylindrical surfaces.

PLATE XV.

Fig. 1.—Exhibits the method of finding the perspective representation of a dome supported upon pendentives. Fig. 1, No. 2, is the plan of the dome, and fig. 4, No. 1, the section. From this the several heights to be applied to the perspective drawn, fig. 1, are found, the corresponding points are marked, 1, 2, 3, 4, 5, both in the section and in the representation. In the perspective drawing, the heights are applied upon the intersecting lines, and by this means the representation of the circles which terminate the pendentives are found.

As to the base of the dome, it is a horizontal circle, and is therefore put in perspective in the usual manner of representing a circle in such a position. One of the faces of the object being parallel to the picture, the objects in this face, when represented in perspective, are similar to the figures in the original face.

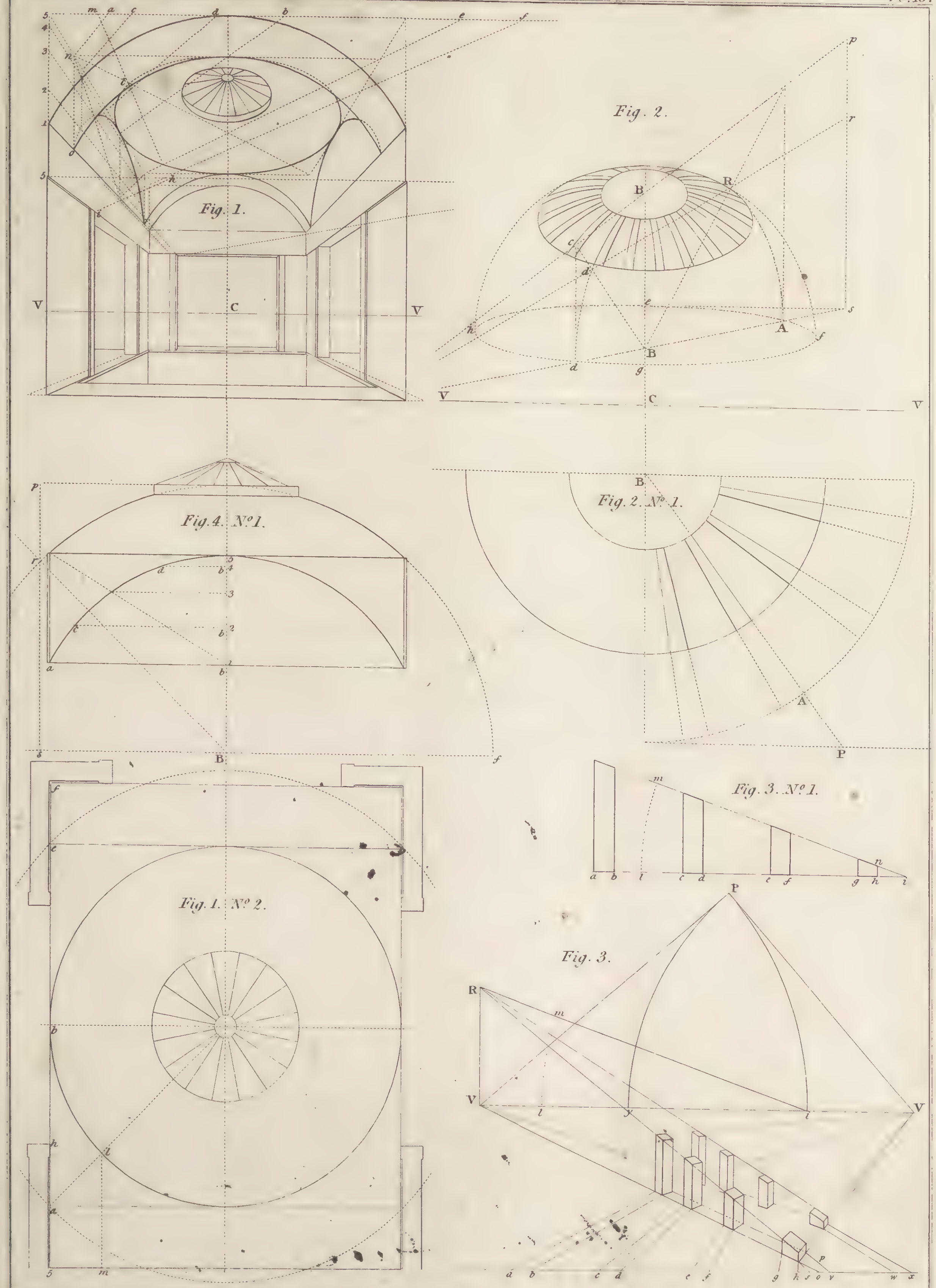
Fig. 2.—Exhibits the representation of a dome divided into coffers or pannels. Fig. 2, No. 1, is the plane of the same. The base of this dome is represented by the dotted circle below.

Fig. 3.—Shews the representation of square posts at equal distances from each other. Fig. 1, No. 1, exhibits the heights and distances of the posts, R is the vanishing line of the tops of each row, found as usual by bringing down the distance of the eye on the vanishing line, and making the angle equal to that in No. 1. The measures in the base of No. 1, are applied on the intersecting line.

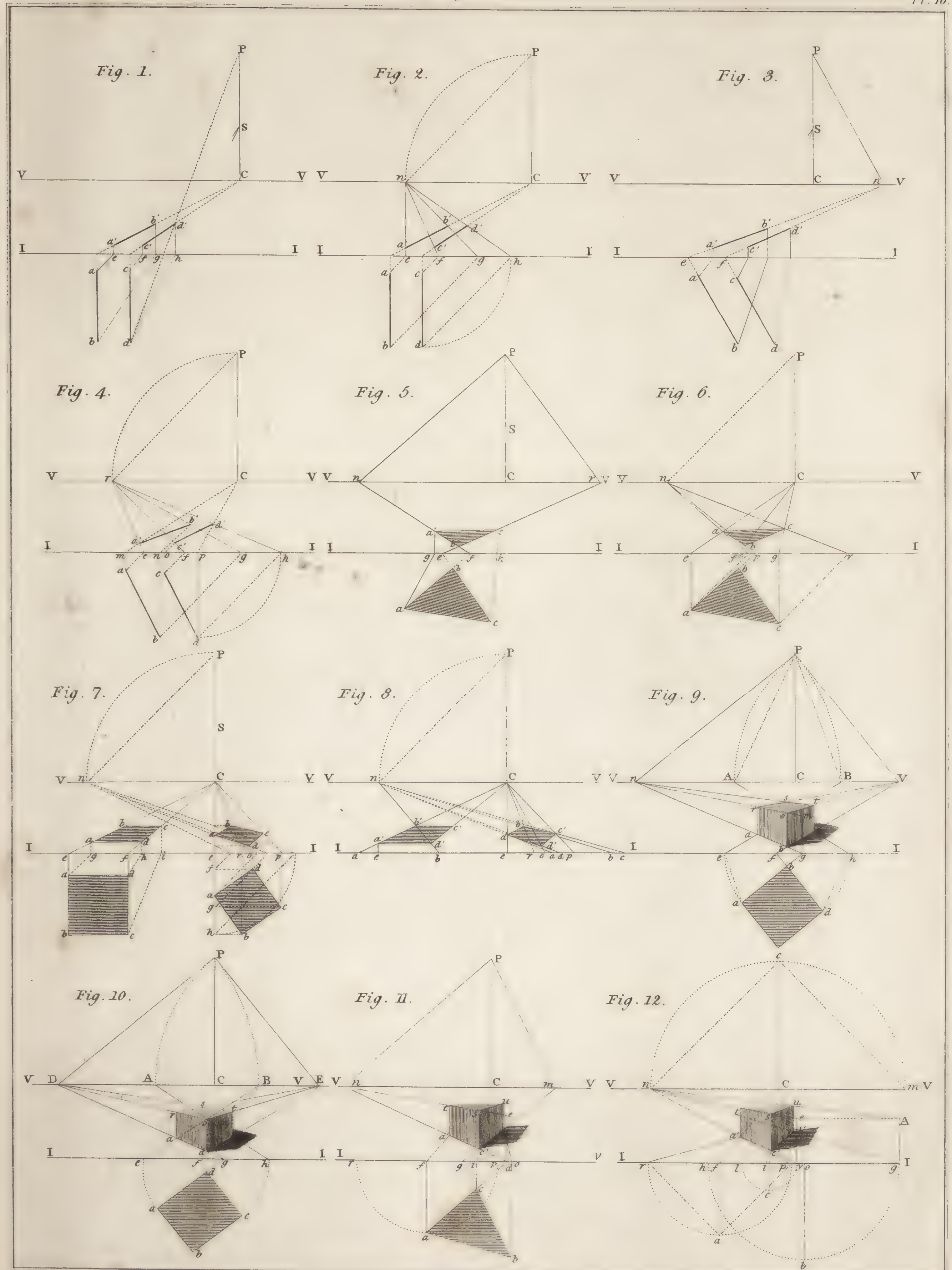
PLATE XVI.

In the twelve following diagrams let V V be the vanishing line, I I the intersecting line, C the centre of the picture, C P its distance, and P the point of sight in relation to the vanishing line V V: here observe, that wherever S is placed in P C the distance P S is equal to the height of the picture; so that the distance from S to the intersecting line is equal to the distance of the picture.

Perspective.



Drawn by M.A. Nicholson.
R. Roffe, sc.
Published by Fisher, Son & Cº Caxton, London, 1835



Designed by M.A. Nicholson

R. Roffe sc.

Published by Fisher, Son & Co. Caxton [illegible]

Hence from what has now been observed, C P is perpendicular and I I parallel to V V.

In order to make one connected operation, the planes of each of the twelve diagrams are placed contiguous to each other, so that when each operation is performed, the vanishing plane, the plane of the juncture, and the original or ground plane, may be all brought into their real positions, and the eye being placed in the point of sight, the spectator would see the originals as he would in nature, or as they would appear as described in the definition of perspective.

The reader is to observe once for all, in the twelve diagrams above alluded to, that as the lines V L, I I, and C P, and the points C and P, are given in position, it will not be necessary to mention them in the enunciations of the problems.

PROBLEM.

To find the representations of lines perpendicular to the intersecting line.

METHOD FIRST.

Let *b a* and *dc* be two original lines: cut I I in the points *e* and *g*, by lines drawn towards S from the points *b* and *a*, and again cut I I in *k* by producing *b a*. Join *k* C, and cut *k* C in *a′* and *b′* by the lines *e a′*, *gb g b′* perpendicular to I I, and *a′ b′* will be the representation of *a b*. In the same manner *c′ d′*, the representation of *cd*, will be found.

METHOD SECOND, FIG. 2.

Cut the line I I in *k* by producing *b a*, and in *e* and *g* by making *ke* equal to *ka*, and *kg* equal to *kb*. Cut the V V *mn* by drawing P *n* parallel to *ae*. Join K C. Find the points *a′ b′* in K C, by joining *en* and *gn* and *a′ b′*, will be the representation of *ab;* *c′ d′* found in the same manner, will be the representation of *c d*.

PROBLEM.

To find the representation of lines that are obliquely situated to the intersecting line.

METHOD FIRST, FIG. 3.

In I I find the point *e* by producing *b a*, and the points *m* and *n* by the lines *a* S, *b* S.

In V V find the point *n* by drawing P *n* parallel to *b a*. Join *en;* and find *a′ b′* by the lines *m a′*, *n b′* perpendicular to I I, and *a′ b′* will be the representation of *a b*. In the same manner, and by means of the same vanishing point, *c′ d′* the representation of *e d* will be found.

METHOD SECOND, FIG. 4.

In I I find the points *m n*, by drawing *am* and *bn* perpendicular to I I, and the points *e* and *g* by making *me* equal to *ma*, and *ng* equal to *nb*. In V V find the point *r* by making E *r* equal to C P. Find the point *a′* by joining *m* C and *er*, and the point *b′* by joining *n* C and *gr:* then *a′ b′* joined is the representation of *a b*. In the same manner, and by the same vanishing point *r*, *c′ d′*, the representation of the line *cd* is found.

PROBLEM.

To find the representation of a triangle *abc*, fig. 5.

Find the points in the intersecting line, where the prolongation of the accessible sides would meet it; find the vanishing points of these sides and their indefinite representations, by joining the intersecting and vanishing points. In each indefinite representation, find the extremity of each end of the remaining side, and join the two points thus found, and the triangle will be the representation of the given triangle.

Thus, in II find *ef*, by producing *cb* and *ab*. Find *n* and *r*, the vanishing points of *ab*, *bc* by drawing P*n*, P*r*, parallel to *ab*, *cb*. Find the indefinite representations *fn* and *er* by joining *fn* and *er*, and the points *a′* and *c′*, by drawing *a*S and *c*S, gives the triangle *a′b′c′* the representation of *a b c*.

The triangle may also be found as in fig. 6, in the same manner as has been shewn in fig. 4.

PROBLEM.

To find the representation of a square, fig. 7, having its sides perpendicular and parallel to the intersecting line.

In II find the points *e*, *f*, by producing *ba* and *cd*, and the points *g*, *h i*, by drawing S*a*, S*d*, S*c*. Join *e*C and *f*C. In *e*C and *f*C find the points *a′ d′ c′* by drawing *ga*, *hd* and *ic* perpendicular to II. Find the point *b′* by drawing *c′b′* parallel to II; then the trapezoid *a′b′c′d′* will be the representation of the square *abcd*.

PROBLEM.

To find the representation of a square obliquely situated to the intersecting line, see the same figure, viz. fig. 7.

In the intersecting line II, find the points *e*, *r*, *o*, *p* by drawing *ae*, *br*, *do*, *cp* each perpendicular to II.

In II find the points C, A, D, B by making *e*C, *e*A, *e*D, *e*B respectively equal to the perpendiculars *od*, *ea*, *pc*, *rb*.

In VV find the point *n* by making C*n* equal to CP. Join *e*C, and in *e*C find the points *f*, *a*, *g*, *h* by drawing the lines C*n*, A*n*, D*n*, B*n*, the point *a′* is the representation of the point *a*. Find the points *b′ c′ d′* by drawing *h b′ g c f d* parallel to II, and by joining *r* C, *p* C, and *o* C, and *a′ b′ c′ d′* will be the representation of the square *a b c d*.

If it be found inconvenient to have the plan on the picture, we may proceed in the following manner, see fig. 8.

Let the plan be drawn on one piece of paper, and posited to the intersecting line, as shewn at fig. 7.

Find the points *e*, *r*, *o*, *p*, as in fig. 7, and transfer them to the intersecting line II, fig. 8, from *e* to the points *r*, *o*, *p*. Draw the lines *r* C, *o* C, *p* C. In II, fig. 8, make *e a*, *o d*, *p c*, *r b* equal to the perpendiculars *e a*, *o d*, *p c*, *r b*, fig. 7. In fig. 8, draw the lines *a n*, *b n*, *c n*, *d n*, intersecting

the line e C, r C, p C, o C, in the points a', b', c', d'. Join $a'b'$, $b'c'$, $c'd'$, $d'a'$, and the trapezium $a'b'c'd'$ is the square required; and similarly that which is parallel to the picture on the left hand may be represented.

In the representation of rectangular solids, the plans must be first represented; but before we proceed to any general method of representation, it is advisable to familiarize them by a few examples.

In the following solids, the rectangular faces, which join the two ends, are called sides of the solid, and the faces to which the sides are joined are called the ends; the end which coincides with the original plane is called the base, and the other end is called the top of the solid; the line in which any two faces meet is called an edge, or the edge of those two faces.

Since the sides of the solid stand upon the base, we shall, first of all, shew how the several bases are found in perspective.

Fig. 9, the base of the solid to be represented, is a square, *a b d c*. In the intersecting line I I, find the points *g* and *f* by producing *a d* and *d b*, the two sides which terminate in the nearest angular point to I I.

Find the vanishing points *n*, *m* of the lines *a b* and *d b*. Find the representation of the nearest point *b* of the base, by drawing *g n*, *f m*. In I I, find the points *e* and *h*, by making *g e* equal to *g a*, and *f h* equal to *f d*. In V V, find the points A and B, by making *m* A, *n* B, respectively equal to the radials *m* P, *n* P. Find the points *a m g n* and *d m f m* by joining *e* B and *h* A; and as the base is a square, this is as much as will be required, the other two edges being covered by the sides of the solid.

The same process is employed in fig. 10, in finding the representations $a'd'$, $d'c'$, of the two edges *d a*, *d c* of the square *a b c d*.

In fig. 11, the point c' which represents the nearest point of the base, is found as in fig. 5, and the points *a* and *b* are found as in fig. 6.

As it has already been observed, that it is often very inconvenient to have the plan and the perspective drawing on the same paper, fig. 12 is supposed to be done without the plan attached to it; a preparation, however, as in fig. 11, must be first made, and the intersecting points of the perpendiculars and their lengths must be transferred to the intersecting line I I, fig. 12, as shewn by the dotted circles; from these the representations of the two edges

of the base, which terminate in the nearest point to the intersecting line, will be found.

Having found the edges of the visible sides in the plan, we shall now proceed to the elevations of the representations of the solids. Produce to the intersecting line one of the representations of the two edges of the base, which terminate in the point of the base which is nearest the intersecting line; from the point where the prolongation meets the intersecting line, draw a line perpendicular to the vanishing line; call this perpendicular the line of heights; on the line of heights set up the height of the solid. Draw a line from the upper point to the vanishing point of the side produced. Thus, in fig. 9, produce *a′ b′* to *g*, and draw *g m* perpendicular to V V. Make *g m* equal to the height of the solid. Join *m n*. In *m n* find the points *o* and *r*, by drawing *b′ o*, *a′ r*. Find the point *t* by joining *o* to the vanishing point *m*, and drawing *d t* perpendicular to V V. Lastly, find the point *s* in *f o g s g* and 10, by joining *t* and *r* to the vanishing points *n*, *m*, and thus we have the complete representations, figs. 9 and 10. Figs. 11 and 12 are completed by joining *t u*.

PLATE XVII.

DIAGRAMS ILLUSTRATING THE PRINCIPLES OF PERSPECTIVE.

In all the diagrams of this Plate, let PS be the point of sight, SP the station point, NW the directing line, OR the parallel of the eye, and VL is the vanishing line.

Fig. 1 is the representation of straight lines in three different planes, two being horizontal and one parallel to the picture; these planes in all the six diagrams are represented as if they were five of the sides of a room, the sixth side being left open for the purpose of seeing into the interior, and one of the five sides, which is the plane of the picture, is supposed to be transparent; one of the two horizontal planes, which is the perpendicular to the picture, represents the floor, and the other the ceiling.

In fig. 1, the lines *i k* and *l o* on the floor, are parallel, and therefore have a vanishing point F found by drawing a line PSF through the point of sight P·S parallel to these lines; the same observation applies to the lines *v r* and *s n*; all these lines are here represented on the plane of the picture by the same letter. In every one of the planes in each of the six diagrams, the lines and

Fig. 1.

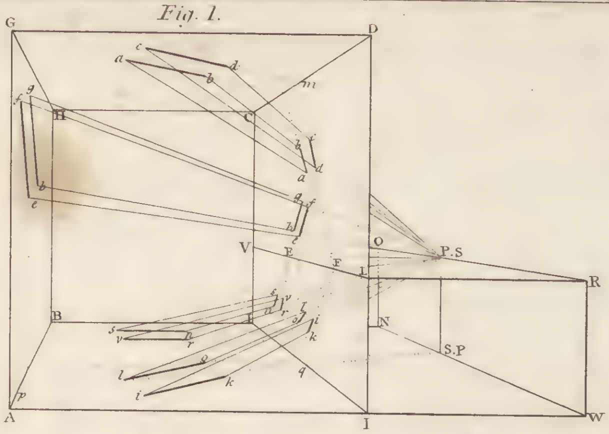


Fig. 2.

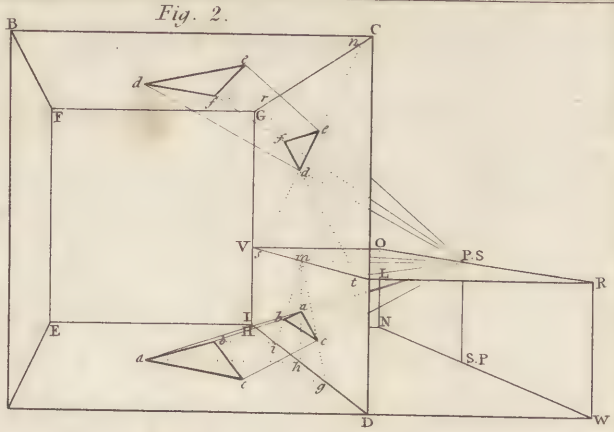


Fig. 3.

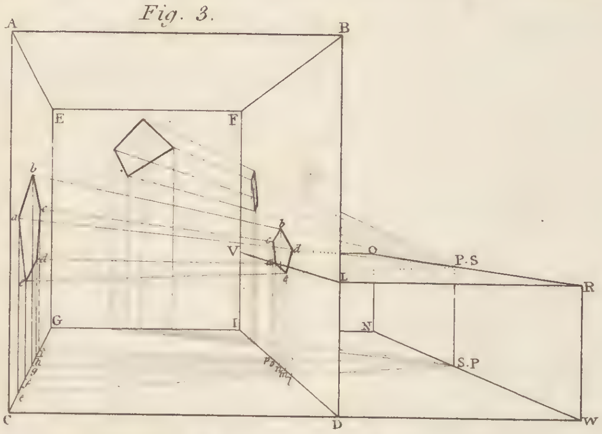


Fig. 4.

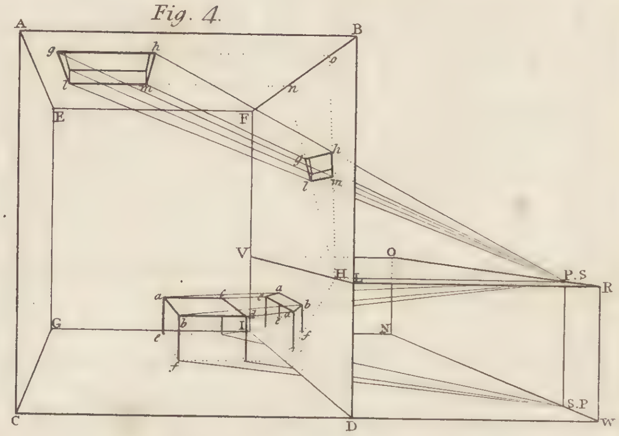


Fig. 5.

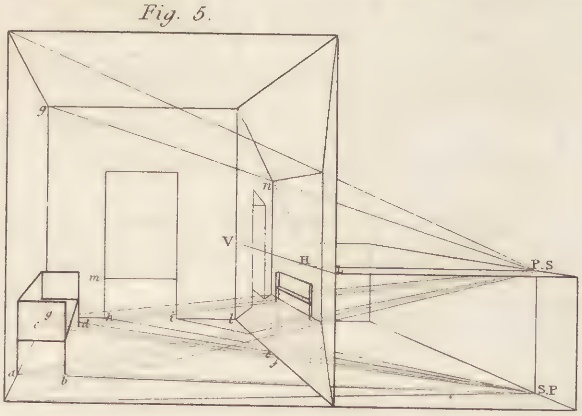


Fig. 6.

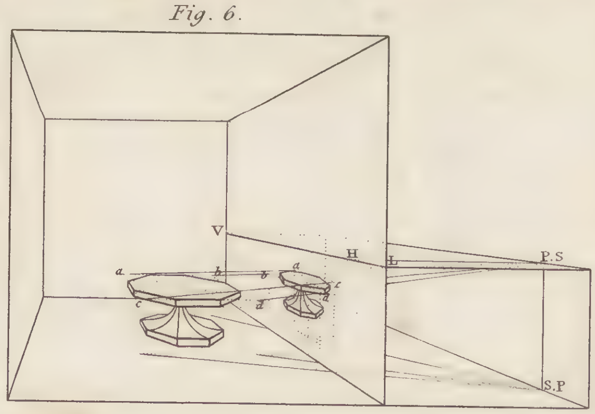


Fig. 7.

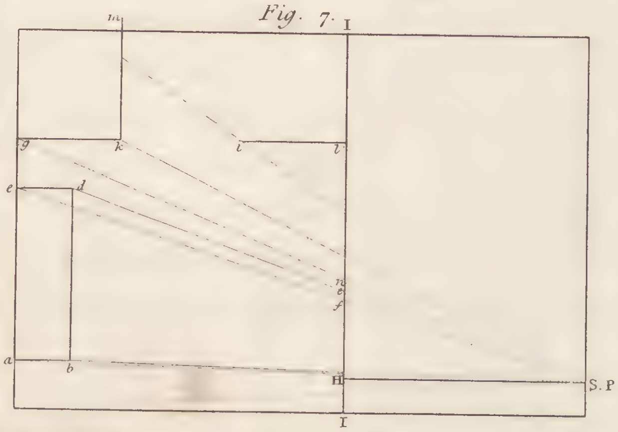
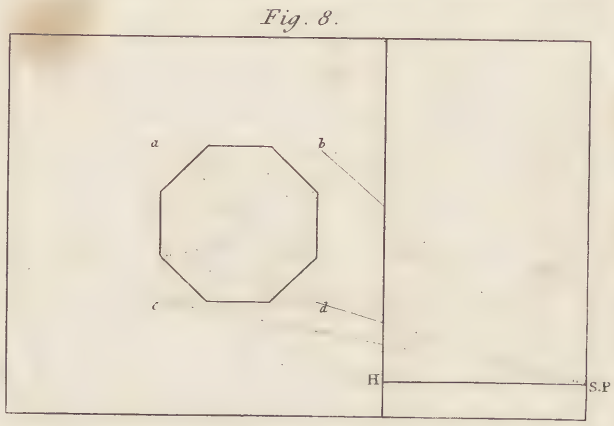


Fig. 8.



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points in the picture have the same letters of reference as the corresponding lines and points of the objects themselves.

In fig. 2, a triangle is exhibited as if lying on the floor, and another on the ceiling.

In fig. 3, a pentagon *abcde* is placed on the side of the room which is parallel to the picture. The method of representing this object is by drawing lines from all the vertices of the figure perpendicular to the floor, and drawing lines from the points where those lines meet the floor to the station point, and again drawing lines on the plane of the picture from the points where the floor and the picture intersect perpendicularly to the line of intersection; then these lines, intersected by visual rays drawn from all the vertices of the polygon upon the opposite wall, will give the vertices of the perspective representation. The trapezium upon the plane of the wall, which is perpendicular to the picture, is represented in a similar manner.

In fig. 4, a table is here represented as if standing on the floor. This is done by drawing lines from the feet of the table upon the floor to S·P the station point, and drawing lines on the plane of the picture from the points of intersection perpendicular to the intersecting line, and by drawing lines or visual rays from the extremities of all the lines of the object to the point of sight, and the points where these lines intersect the former in the plane of the picture will be the perspective representations of the corresponding points of the object thus drawn from. In this figure a hatchway is represented in the ceiling. In each of these objects the sides are parallel and perpendicular to the plane of the picture, therefore the lines which are perpendicular to the picture vanish in its centre.

The method of representing the objects in figs. 5 and 6, is similar to that now explained, and therefore need not be repeated. Fig. 7 is the plan of fig. 5, and fig. 8 the plan of fig. 6; these plans exhibit the positions of the objects, the station point, and the manner of drawing the lines towards it from all the points of the object, so as to give their intersecting points on the plane of the picture.

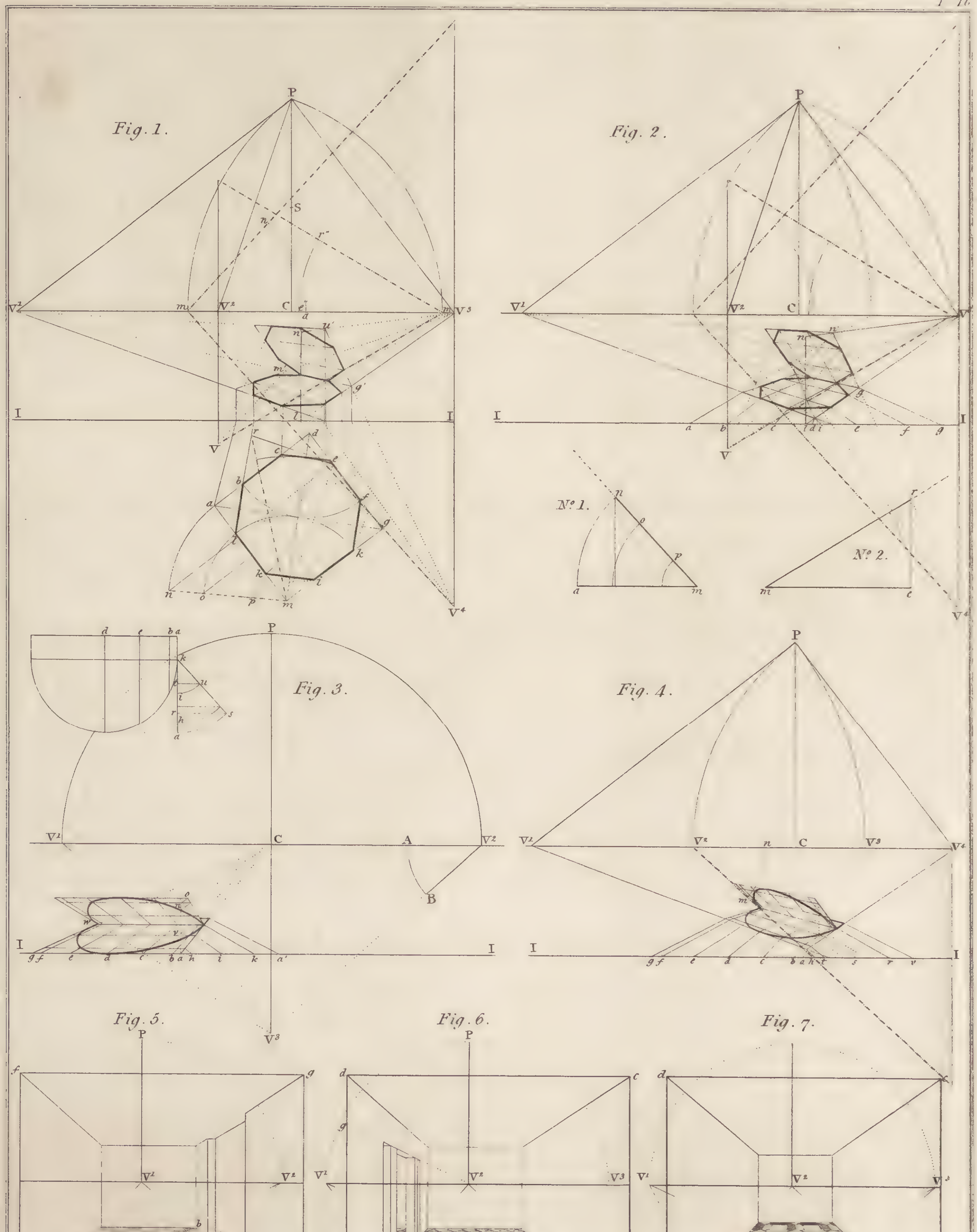
PLATE XVIII.

ILLUSTRATION OF VARIOUS PROBLEMS.

Figs. 1 and 2, exhibit the method of finding the perspective of an octagon, both horizontal, and inclined to the horizon at a given angle. The representation, fig. 1, is made from the plan, and that in fig. 2, is found from the measures being applied upon the horizontal vanishing line.

Figs. 3 and 4, exhibit the method of finding the perspective representation of a semicircle, both in a horizontal and in an inclined plane, as if they were connected together by the same common diameter. Both these representations are found by means of the measures of the object applied to the intersecting line. In fig. 3, the diameter which connects the two semicircles, is parallel to the picture; but in fig. 4, it is oblique. In fig. 3, the centre C of the picture is the vanishing point of the lines that are perpendicular; the other parallel series of lines, being parallel in the object, are represented by lines parallel to the intersecting line. In fig. 4, neither of the two series of parallel lines of the object being parallel to the intersecting line, the vanishing point of one series will be on one side of the centre, and that of the other series on the other side of the centre. The manner of finding the intersecting points, and the angle which the two semicircles make with each other, is exhibited above, fig. 3.

Figs. 5, 6, 7, exhibit the perspective representation of a room where the floors are laid with various kinds of pavement. In fig. 2, the lines of the pavement being perpendicular to the plane of the picture, the vanishing point of these lines is in the centre; the breadths are regulated by the point of distance V^2. In fig. 6, the lines are regulated by two vanishing points, equally distant from the centre of the picture. Fig. 7, is a combination of the two.



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FISHER, SON, & Co LONDON, 1833.

THE METHOD OF DRAWING LINES TO INACCESSIBLE VANISHING POINTS.

The drawing of lines to a point out of reach was long a desideratum, and numerous complex schemes were introduced to accomplish this desirable object: at length, Mr. J. Fary and Mr. P. Nicholson produced instruments nearly at the same time, which would completely effect the purpose. In May, 1814, the Society of Arts voted to Mr. P. Nicholson the sum of twenty guineas, for the invention of the centrolinead. Mr. Fary produced his instrument for drawing lines converging to an inaccessible point, very shortly after, and was also rewarded by the Society of Arts. The principle of these instruments, though they had the same object to accomplish, was very different. The one invented by Mr. Nicholson, in performing, moved in the manner of a parallel ruler; but the other, invented by Mr. Fary, consisted of three bars, so that two of them being moved to any given angle, the edge of the third bar always besected those of the other two, and the motion of the instrument was regulated by sliding these two last edges each upon a pin, in the same manner and upon a similar principle to that of describing the segment of a circle by means of an angle. However, as Mr. Nicholson had previously shewn another instrument, upon the same principle as Mr. Fary's, to several of the members of the Society of Arts, he was encouraged by those gentlemen to bring forward his second invention of the centrolinead, which he produced accordingly, and was rewarded with the silver medal of the Society in the year 1815.

This last instrument has been found to be of the greatest use to artists. It is much more simple in its construction than Mr. Fary's, which required him to perform a geometrical operation, before the pins, upon which the instrument moved, could be fixed. Mr. Nicholson's last instrument for drawing lines to a vanishing point, as presented to the Society of Arts, was simply constructed upon the principle of a double bevel, in which each angle was independent of the other, and might be set to any two angles less than 180°.

This instrument was made to shift to the right or left by means of screws and brass plates. Shortly after his reward, Mr. Nicholson published a small tract on the use of the centrolinead. In this little work he exhibited and explained the manner of making an immoveable or solid centrolinead, to answer the drawing of lines which would converge to a point at any given distance. He now makes three solid or fixed centrolineads, at one-fourth of the expense, to answer every degree of convergency, and these he applies with the greatest expedition; but before the centrolinead can be used, it will be necessary to shew how the first two converging lines on the right or left hand sides of a building, or piece of furniture, of which the plan is a rectangle, are found.

Let *a b c*, fig. 1, Plate XVIII. for instance, be the plan of two sides of the frame of a table, or two sides of a building, and let I L be the sectional line of the picture, placed in the position required by the draughtsman.

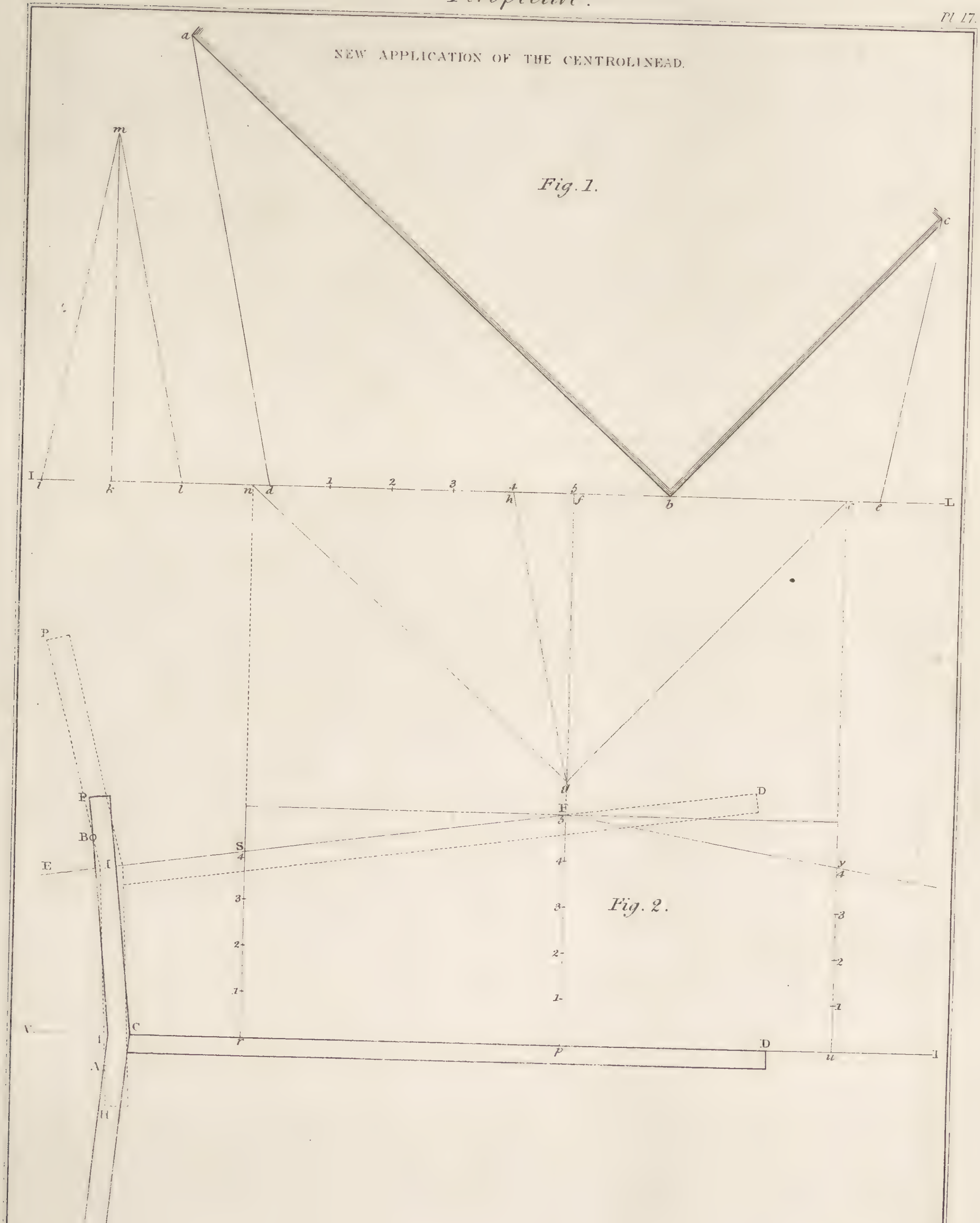
In order to avoid distortion, every picture should be viewed in the middle, and the horizontal visual angle should be given; that is, the distance of the eye ought to bear some ratio or proportion to the length of the picture. We shall here suppose that the picture is viewed at a distance which will be two and a half times its length; that is, supposing the picture to be two feet long, as in large drawings, the distance of the eye would be five feet; therefore, from any convenient point *k*, in the line I L, draw *k m* perpendicular to I L. In I L, take the point *i* at any convenient distance from *k*, and in I L make *k l* equal to *k i*. In *k m* set off *i l* two and a half times from *k* to *m*, and join *m i* and *m l*. In I L cut off the length of the picture *d e*, by drawing *a d* parallel to *m l*, and *c e* parallel to *m i*. The picture must now be viewed at a distance equal to two and a half times *d e*; that is, about ten inches and five sixteens. Now, this distance would exceed the extension of the surface which we have here to work upon; but if it can be shewn how the drawing may be completed equally well, without extending the lines *a d* and *c e* till they meet, we should be most happy to avail ourselves of the information, in avoiding so great an inconvenience and so much more labour.

Bisect, then, *d e* in the point *f*, and draw *f g* perpendicular to I L. Divide *d f* into five equal parts. Cut the line *f g* in *g*, by drawing *h g* through the fourth point *h* of division parallel to *a d* or *m l*, then will *f g* be a fifth part of the real distance of the picture; and if the drawing or paper had not admitted of this distance, *d f* must have been divided into a greater number of equal parts; for *f g* would be shorter in proportion to the greater number of equal parts which are contained in *d f*; so that if *d f* had been divided into six equal parts, *f g* would have been one-sixth part of the distance of the picture, and so on.

In I L, cut the points *n* and *c*, by drawing *g n* parallel to *b a*, one side of the plan, and *g c* parallel to *b c*, the other side.

Let V L, fig. 2, be the vanishing line, either on the same paper, or on another, as may be convenient. In V L assume the point *p* for the centre of the picture.

NEW APPLICATION OF THE CENTROLINEAD.



In V L cut off the distances $p\,r$ and $p\,u$ respectively, equal to $f\,n$ and $f\,c$ in the line I L, fig. 1. In fig. 2, draw the lines r S, p F, and $u\,y$ perpendicular to V L. Set the points of the dividers at any convenient distance from each other, and set off as many equal parts in p F, and as many equal parts wanting one in r S and $u\,y$, as $d\,f$, fig. 1, was divided into: now, $d\,f$ was divided into five equal parts, therefore p F contains five, r S and $u\,y$ contain each four of such parts as the dividers were set to.

Draw the straight lines F S and F y. Produce F S to E. H I P C D represents the instrument, H I, I P are the two straight edges that run upon the pins, and I D is the edge of the instrument by which the lines are drawn.

There are here given two straight lines E F and V L, which would tend to the proper vanishing point, if produced. The distance in which they will meet the line V L produced on the left, is five times the distance $n\,f$, fig. 1.

Suppose, now, the edge C D of the centrolinead to be placed on the vanishing line V L, put a pin in the paper in any convenient point A of the running edge I H, and draw a line I P on the paper by the other running edge I P. Shift the instrument, so that the edge I D of the blade may coincide with the line E F, and the edge I H still rest against the point A; then draw a new line I P. Put another pin in the intersection B of the two lines I P, I P.

Lastly, move the centrolinead until the edge C D fall upon any given point between the lines E F and V L, so that the edge I H may rest against the point A, and the edge I P against the point B, and draw a straight line by the edge I D, and the straight line thus drawn will tend to the same point in which the other two given lines E D and V L would meet each other, if produced.

In this manner lines tending to a vanishing point, may be drawn with as much expedition, as perpendicular lines could be drawn by a common T-square, or parallel lines by a parallel ruler; and more lines may be drawn by the instrument in five minutes, than could be drawn in twenty four hours by finding each line separately by a geometrical problem.

THE PERSPECTIVE OF SHADOWS.

The shadows of objects are the dark parts on the surface of a body or plane, occasioned by the intervention of another body which intercepts the rays of light.

In projecting shadows by the sun, there are three different positions of the luminary to be considered; viz. it must either be in the plane of the picture, or on the same side of the picture with the spectator, or behind the picture

In order to determine the shadows of objects on the plane of the picture, the situation and altitude of the sun must be determined; then, whether the sun is before or behind the picture, the vanishing point of the rays of light must either be found or assumed; but when the sun is in the plane of the picture, the rays will be parallel to the picture, and therefore the representations will be parallel.

When the sun is on the same side of the picture as the spectator, it is obvious that the vanishing point of the rays of light will be below the horizontal line; and if on the other side, above it.

When a straight line obstructs the sun's rays, it is evident that the rays thus intercepted are all in a plane passing through the luminary and through that line. The opaque surface occasioned by the obstruction of the sun's rays, is called a plane of shade. It is therefore evident, that the plane of shade passes through the luminary and through the straight line. Hence the indefinite shadow of a line upon a plane is the intersection of that plane and the plane of shade.

If therefore we have the vanishing point of a line that throws a shadow upon a plane, and the vanishing point of the sun's rays, we have the vanishing points of two lines in the plane of shade, and therefore the vanishing line of the plane of shade; and if we have the vanishing line of the plane of shade, and the vanishing line of the plane on which the shadow is thrown, we shall have the vanishing point of the shadow. For the shadow itself is the intersection of the plane of shade, and the plane on which the shadow is thrown; therefore the vanishing point of the shadow is the intersection of the two vanishing lines of these planes.

If the vanishing line of the plane of shade be parallel to the vanishing line of the plane on which the shadow is thrown, it is evident the shadow of the line will be parallel to the vanishing line of the plane on which the shadow is thrown, or parallel to the vanishing line of the plane of shade; for these two vanishing lines can never intersect each other.

If the line which throws a shadow be parallel to the plane on which the

shadow is thrown, the line and its shadow will have the same vanishing point.

When the line which throws a shadow on a plane is perpendicular to that plane, and when the plane is parallel to the picture, the vanishing point of the line will be in the centre of the picture; therefore the vanishing line of the plane of shade will be the line joining the vanishing point of the sun's rays, and the centre of the picture; and since in this case the shadows of lines thrown upon any plane, by lines perpendicular to that plane, are all parallel among themselves, the shadows of these lines will be all parallel among themselves.

The shadows of objects projected upon horizontal planes, by lines inclined at any given angle to these planes, will have their vanishing points in the vanishing line of horizontal planes.

MOST USEFUL PRACTICAL OBSERVATIONS.

With respect to the shadows of perspective drawings of Cabinet Furniture, and Architectural objects, as the objects are placed upon the horizon, and since generally the surfaces are planes, and rise perpendicular to the base, the edges of every two adjacent surfaces thus rising from the base will be straight lines perpendicular to the horizon: and as the picture is generally perpendicular to the horizon, the perpendicular lines of the object will be parallel straight lines to the plane of the picture, and will therefore have their perspective representations perpendicular to the vanishing line of the horizontal planes.

Again, as every two planes of the object are generally at right angles to each other, those planes which are perpendicular to the horizon will have their two vanishing lines perpendicular to the vanishing line of the horizontal planes; and because the base on which the object stands, and all the opposite planes above the base, are parallel to the horizon, the lines which terminate these planes will have their vanishing points in the vanishing line of the

horizontal planes; and as all the horizontal lines of the object belong also to the vertical planes of the same object, the horizontal lines will also have their vanishing points in the two vanishing lines, which are perpendicular to the horizontal vanishing line.

Hence, the points of intersection of the two vanishing lines of the planes which are perpendicular to the horizon, and the vanishing line of the horizontal planes, will be the vanishing points of all the horizontal lines of the object.

The vanishing point on the one side is the vanishing point of every line which is perpendicular to any one of the parallel vertical planes, of which the perpendicular passing through the other vanishing point is their vanishing line. Or these two vanishing points may be considered the vanishing points of two lines in a horizontal plane at right angles to each other.

With regard to the effect which the position of the planes of such objects have upon the shadows, we shall observe, that whatever position the luminous point has in respect of the three vanishing lines now alluded to in these observations, as the vertical lines of the object are represented by lines which are perpendicular to the vanishing line of the horizontal plane, these lines may be considered as having their vanishing point in a line drawn through the centre o the picture perpendicular to the vanishing line of the horizontal planes, and at an infinite distance in the line thus drawn.

And since the vanishing line of the plane of shade of a straight line projecting a shadow on a given plane, is a straight line passing through the vanishing point of the sun's rays, and through the vanishing point of the line which throws the shadow; therefore, with regard to the perspective representation of the shadows of the lines which are perpendicular to the horizon upon any horizontal plane, as these lines have their vanishing points at an infinite distance from the centre of the picture, and in a perpendicular to the vanishing line of the horizontal planes, a line drawn from the vanishing point of the sun's rays to this infinitely distant vanishing point, must be perpendicular to the vanishing line of the horizontal planes, the conclusion is, that—

The vanishing line of a plane of shade of a line perpendicular to a horizontal plane, is a straight line drawn through the vanishing point of the sun's rays perpendicular to the vanishing line of the horizontal planes.

And because the vanishing point of the shadow of any line meeting a plane upon that plane, is in the vanishing line of that plane—

The vanishing point of the shadow of a line perpendicular to a horizontal plane, projected upon any horizontal plane whatever, is that point in the vanishing line of the horizontal planes, where a straight line drawn from the vanishing point of the sun's rays perpendicular to this said vanishing line of the horizontal planes, meets it.

With regard to the representation of the shadows of the lines of the object which are perpendicular to the vertical planes upon these vertical planes, as the vanishing point of the lines which throw the shadow are one of the two vanishing points in the vanishing line of the horizontal planes—

The vanishing line of the plane of shade of a straight line perpendicular to a vertical plane, projecting a shadow on this vertical plane, is a straight line drawn from the vanishing point of the line to the vanishing point of the sun's rays, the vanishing point of the line which throws the shadow being one of the two vanishing points in the horizontal vanishing line.

But as the plane on which the shadow is thrown is vertical, the vanishing line is the line drawn through the other vanishing point perpendicular to the vanishing line of the horizontal plane; hence—

The vanishing point of the shadow of a straight line perpendicular to a vertical plane upon this plane, is in the perpendicular drawn through the other vanishing point, which is not the vanishing point of the line to the vanishing line of the horizontal planes.

PLATE XIX.

APPLICATION OF THE THEORY OF SHADOWS TO REAL PRACTICE.

B C D E, fig. 3, represents a wall in perspective. In this example the sun is supposed to be in the plane of the picture, therefore the perspective representation of every ray of light makes the same angle with the vanishing line of the horizontal planes, as the altitude of the sun makes with the horizon; and consequently, the sun's rays have no vanishing point but what is infinitely distant.

Now the vanishing line of the plane B C D E is the line V A drawn through the left hand V perpendicular to VV, the vanishing line of the horizontal planes, and the vanishing point of the lines which throw the shadow is the right hand point V in the vanishing line VV of the horizontal planes.

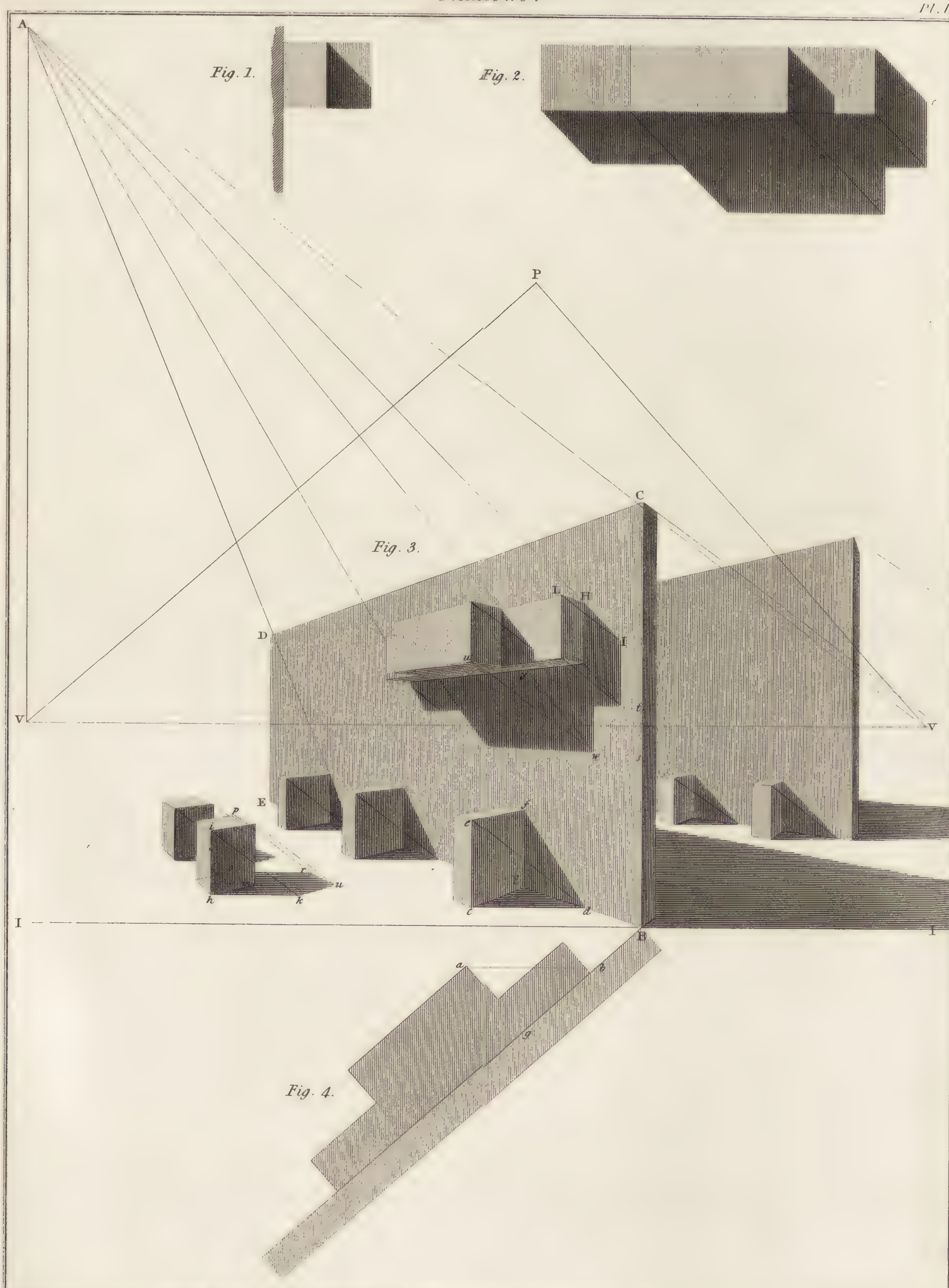
Therefore as V is the vanishing point of the lines which throw the shadow, the vanishing line of the plane of shade must pass through V, making an angle with VV, the vanishing line of the horizontal planes, equal to the angle which a ray of the sun makes with the horizon; therefore draw the sloping line V A through the right-hand vanishing point V, making the angle V V A equal to the angle which a ray of light makes with the horizon, and the sloping line V A will be the vanishing line of the plane of shade. But V A perpendicular to V V is the vanishing line of the plane on which the shadow is thrown, therefore the point A in which the sloping vanishing line V A of the plane of shade, and the vertical vanishing line V A of the plane on which the shadow is thrown, meet each other, is the vanishing point of the shadow.

From what has been said, the perspective representations of the rays are all parallel to the sloping line V A, and the indefinite shadow of any line perpendicular to the plan represented by B C D E will pass through the point A, and through the foot of the lines, and we have the law for drawing the indefinite perspective shadow of the line and the perspective of the ray of light which passes through the unconnected extremity of the line.

Therefore to find the shadow of any such line, we have only to draw a line from A the vanishing point of the shadow, and through the foot of the line, and to draw another line through the unconnected extremity parallel to the sloping line V A, and the point where this line intersects the indefinite perspective shadow will terminate the shadow required, or the portion of the indefinite shadow between the foot of the line which throws the shadow and the point of intersection of the perspective representation of the indefinite shadow of the line, and the perspective of the ray of light drawn through the unconnected extremity, will be the shadow of the line.

Fig. 4, is the plan of a body projecting from the face of the wall, consisting of several faces which are plane surfaces, every two adjacent planes being prependicular to each other, and those which are adjacent to the wall

Shadows.



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Dick sc.

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perpendicular to the plane of the wall; hence all the straight lines formed by the intersection of the planes perpendicular to the wall, will also be perpendicular to the wall, and therefore parallel to the horizon; hence their vanishing point will be on the horizontal vanishing line, and consequently, in the right-hand point V, which is the vanishing point of lines perpendicular to the plane represented by B C D E, of which the vanishing line is V A, perpendicular to the horizontal vanishing line V V; and as these planes are either perpendicular or parallel to the horizon, the intersections of the planes which are parallel to the wall, with the planes which are perpendicular to the wall, but at the same time parallel to the horizon, will be both parallel to the wall and to the horizon; and the intersections of all those planes which are parallel to the wall, with those which are at the same perpendicular to the wall and to the horizon, are all perpendicular to the horizon, and consequently parallel to the picture.

Therefore, all the lines which are perpendicular to the horizon and parallel to the picture will be represented by lines perpendicular to the vanishing line of the horizon, and the representation of the shadows of these lines will also be perpendicular to the vanishing line V V of horizontal planes

Fig. 1 is an end elevation of the plan fig. 4, and fig. 2 is a front elevation of the same projecting body. H I projecting from the plane represented by B C D E is one of the upper edges, L being the upper extremity, and H the foot of the line L H.

To find the shadow of the line L H. From the vanishing point A of the sun's rays, and through the foot H of the line, draw A I, and draw L I parallel to A V the vanishing line of the plane of shade; then H I is the shadow of the line, H L and I the shadow of the point L.

The edge of the vertical line under L will be found by drawing a line through I downwards perpendicular to the vanishing line V V of the horizon.

In the same manner the shadow of the opposite side of the rectangle will be found, as also the shadows of all the lines which are perpendicular to the plane represented by B C D E.

We now come to the shadows of those solids which are situate upon the plane of the horizon, and of which their surfaces are planes at right angles to one another, and parallel and perpendicular to the horizon. In this case the perspective representation of the rays of light will still be found by drawing lines parallel to the sloping vanishing line V A of the plane of shade.

But now the vanishing point of lines perpendicular to the horizontal plane, being in a perpendicular drawn through the centre of the picture, and being infinitely distant from this centre, therefore the line which is thus parallel to the sloping line A V drawn, this infinitely distant point can never reach the vanishing line V V of the plane on which the shadow is thrown; hence the vanishing point of the shadow must be in the line V V, infinitely distant from the centre of the picture; therefore the perspective representation of all lines perpendicular to the horizon, will be parallel to the vanishing line V V of the horizontal plane.

Let *h i* represent one of the edges of a solid of which each pair of the adjacent sides are perpendicular to each other, and let this solid be so situate that one of its planes may coincide with the plane of the horizon, then calling this plane the base, the other four planes which join the base will be perpendicular to the horizon; and consequently, the four edges formed by every two of these planes will be perpendicular to the horizon, and all of an equal height above it.

The line *h i* being one of these four perpendicular edges, the shadow of the line *h i* will be found thus: Draw *h k* parallel to V V, and *i k* parallel to the sloping line A V, then *h k* will be the perspective shadow of the line represented by *h i*. In the same manner the shadow of the other edges will be found; then to complete the shadow, we have only to join the corresponding points.

PLATE XX.

Fig. 1, exhibits a prismatic solid, with a projecture in front: O is the vanishing point of the sun's rays. As the shadows are to be thrown upon a horizontal plane by lines perpendicular to the horizon, the vanishing point of the perspective representation of the shadow will be the point in the vanishing line of the horizontal plane, cut by a perpendicular to the said horizontal vanishing line, drawn through the vanishing point of the sun's rays. Hence, by drawing O L perpendicular to V L, we have the vanishing point of the sun's rays.

Thus now, to find the shadow of any line, as *a b*, draw *a* L and *b* O, intersecting each other in the point *c*, thus *a c* is the shadow of the line *a b*. In the same manner the shadow *d f* of the line *d e* will be found, and joining *c f*, *c f* will be the shadow of the line *b c*, and *a c f d* will be the shadow of the plane *a b c d*. In the same manner we shall find the shadow of the other planes.

Fig. 1.

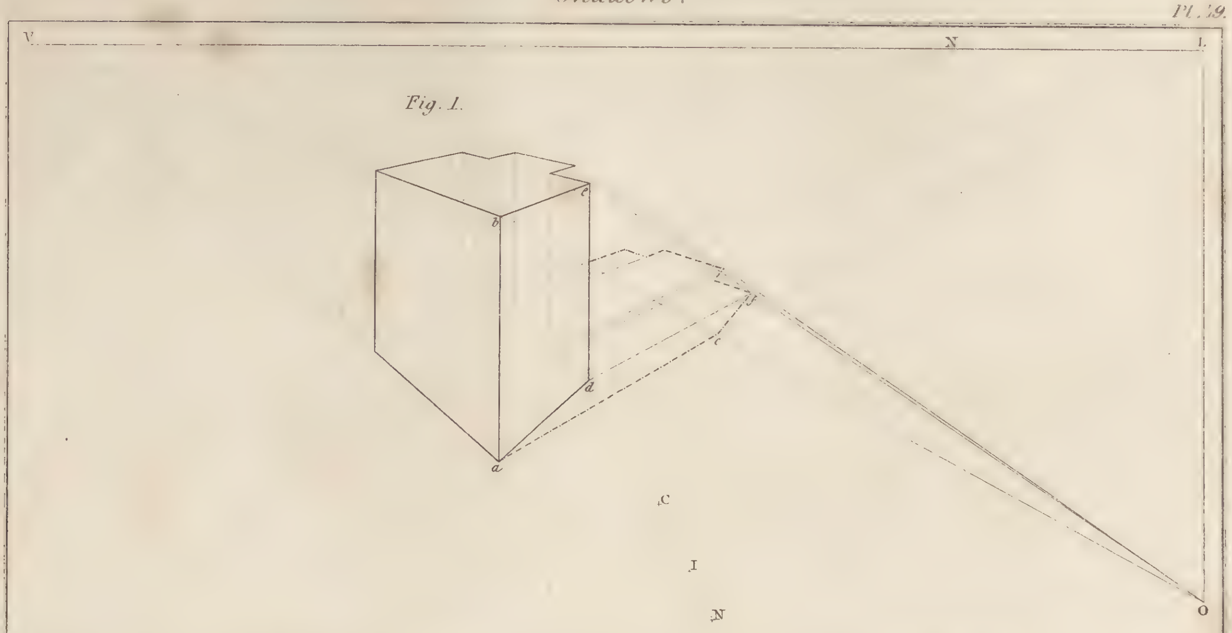


Fig. 2.

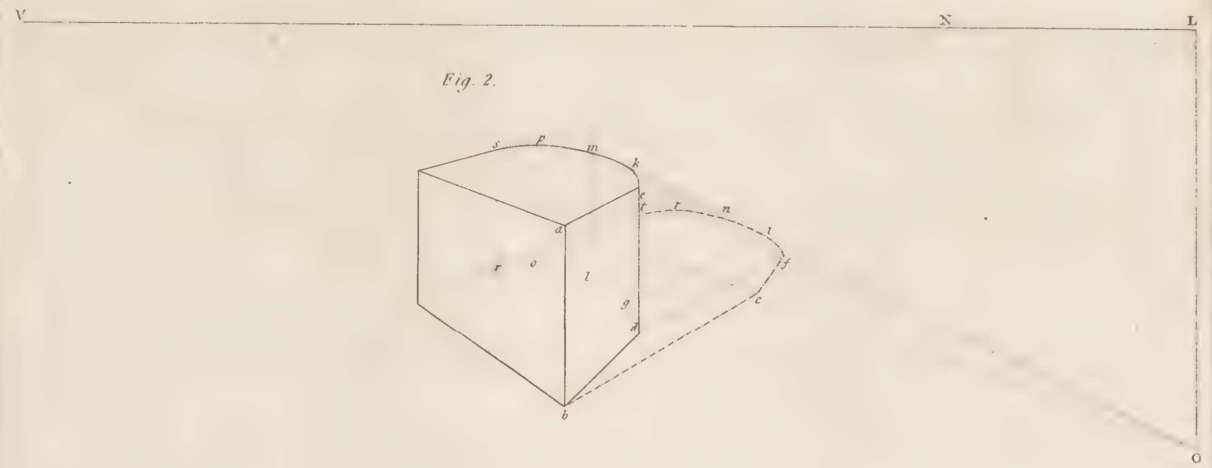
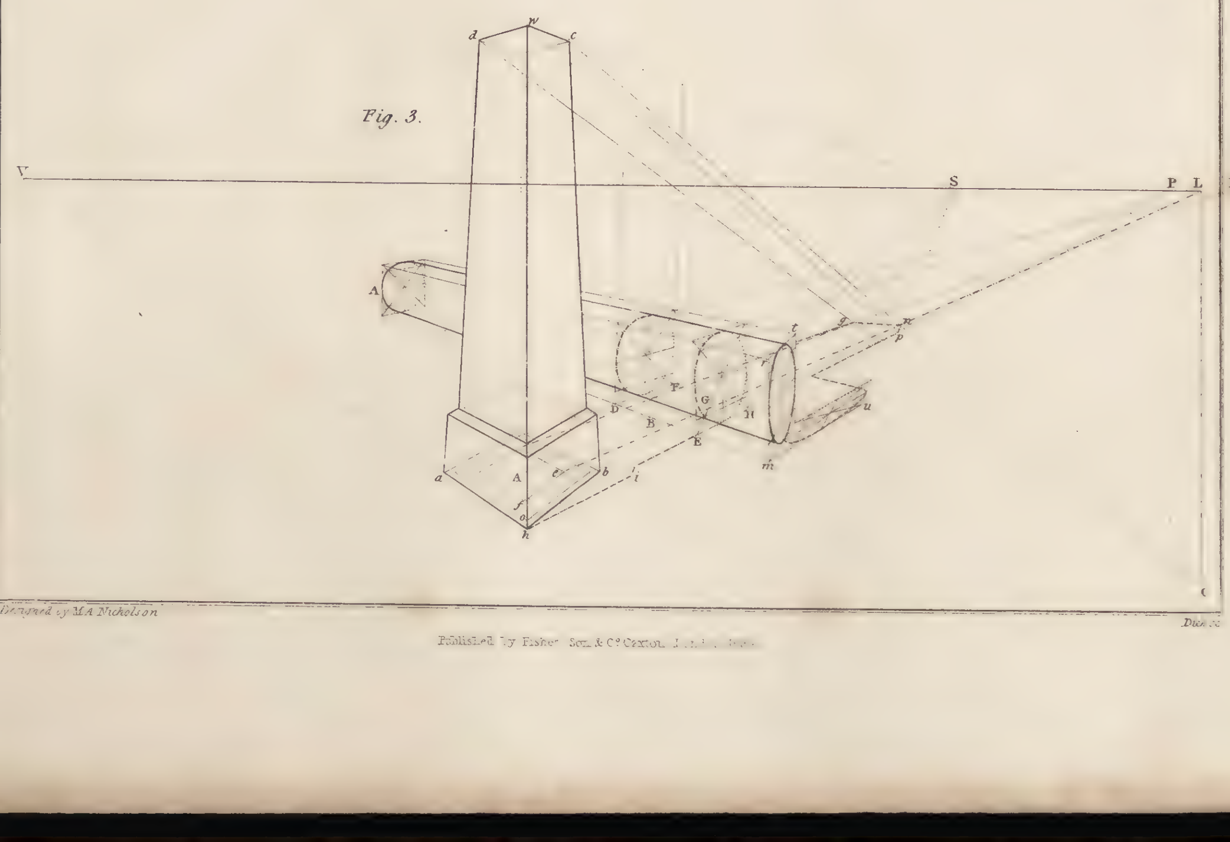


Fig. 3.



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In fig. 2, after having found *c*, *f*, *n*, *r*, *t*, the representations of the shadows of the upper extremities *a*, *b*, *e*, *k*, *l*, *m*, *p*, *s* of the perpendiculars *b a*, *d e*, *g k*, &c. in order to complete the shadow, there is nothing more to do than to trace a curve through the points *c*, *f*, *i*, *n*, *r*, *t*.

Fig. 3, exhibits an obelisk projecting a shadow upon a cylinder, and upon the plane of the horizon: the obelisk stands with its base perpendicular tc the horizontal plane, and with its edges equally inclined to the axis which is perpendicular to the horizon. The perspective representation of the square on the top must be also found in the base; by this means the perpendiculars from the upper extremities will be found in the same manner as in the two preceding examples, and by connecting the extremities the whole will be found complete. The shadow of the cylinder upon the horizontal plane is found by making a sufficient number of sections through the cylinder, and in the plane passing through the line that throws the shadow, and the sun.

We have now finished our article upon Perspective. Its application to the following elegant subjects will explain more of its use to the designer and cabinet-maker than volumes of words could explain.—The subjects to which it is applied throughout this work are the following:

Four-post beds	Drawing-room chairs
Sofa	Card-tables
Occasional table	Music-stool
Side-board	Circular table
Library table	Chair in which the Duke of York died
Bed in the Grecian style	
Couch in the Grecian style	Book-case.

In the design of the Grecian couch, the vanishing line is out of the picture; but as it is now supposed that the reader is in possession of the principles, he can very easily supply its place in imagination. The measures are applied along the ground line as exhibited at the bottom, and the perspective lengths are cut off by means of the points of distance; these points

of distance being the distance between each vanishing point and the eye transferred upon the vanishing line.

SCHOLIUM.

The use of perspective representation is to shew objects in the most natural manner, and to the greatest advantage, so as to give a correct idea of the combinations of their various parts; and though by having the centre and distance of the picture, and knowing that the angles of the object are right angles, the correct length of every line might be obtained; or, if the centre and distance of the picture be given, and the two vanishing points, we shall be able to obtain the original lengths and angles of all the parts of the object; but the centre and distance of the picture are seldom given; and if they were, the reverse process of finding the original lengths and angles of the lines would be so tedious, as to exhaust the patience of the draughtsman, or persons employed to execute the work

A perspective drawing may answer to innumerable angles; but one thing we should observe, that when the distance of the picture is a mean proportional between the distance on the vanishing line from the centre of the picture, and each vanishing point; and if the object have only two vanishing points, the angles are all right angles.

It is necessary to mention these circumstances, that the reader may see the whole extent of the use of perspective, which will save his time by preventing him from making useless researches

Once for all, in perspective, as far as regards the cabinet-maker:—Though a plan of the object is often drawn for the use of the workman, yet he or the draughtsman generally applies the measures upon the ground line, and they do not draw from a station point, as architectural draughtsmen are accustomed.

Orthographical representation gives the same connexion of parts as perspective representations; and though it does not shew the object quite so natural, it has this great advantage, that all the parts can be measured by means of a scale, and therefore the object can be readily put into execution

Indeed, the difference between perspective representation taken at a very long distance, and an orthographical representation, is so trifling, as hardly, in many instances, to be perceived, as will be easily seen from the following objects, which are all orthographically represented:

Escritoir	Sofa
Lady's wardrobe	Chiffonier

Dressing-table and dressing-glasses.

We cannot say more than we have already observed under the article of orthographical projection, and shall only repeat, that the three directions of the solid angle may be assumed by any three lines which may be agreeable to the eye; the scale may be found for lines in each of the three directions. In order that the reader may know which of the scales belongs to any given direction, the scale is always applied parallel to the lines which are measured by it; that is, vertical lines by the vertical scale, oblique lines by the oblique scale, parallel to these lines.

In point of drawing, orthographical representation admits of much more rapid execution than perspective representation.

Throughout the whole of "The Cabinet-maker," wherever the sides of furniture are geometrically represented, we have always affixed a scale, in order to obtain the dimensions of the parts, so that any of the designs may be put into execution. The designs thus represented are—

Window-curtains	Window-seats
Candelabra	Side-board
Firescreen	Side-board and Celeret
Chairs	Cabinet and looking-glass
French bed	Looking-glass
Tea-poy	Circular-table
Tripod and Stand	Drapery for three windows
Sofa	Ladies' work-tables
Stools	Hall-seat, bason-stands, and pot-de-chambre recess
Pier-tables	

Card-tables
Couch
Music-stools
Circular library-table
Plan of a circular-table
Wine-coolers
Upright piano-forte in the Grecian style
Upright piano-forte in the Gothic style.

PLATE XXI.

Finding the angle ribs for canopies upon square, rectangular, polygonal, and circular plans; describing the forms of their veneers, mitering trays in the form of the frustum of a pyramid; method of enlarging and diminishing moulding, and of tracing the sections and mitres of raking mouldings.

PROBLEM.

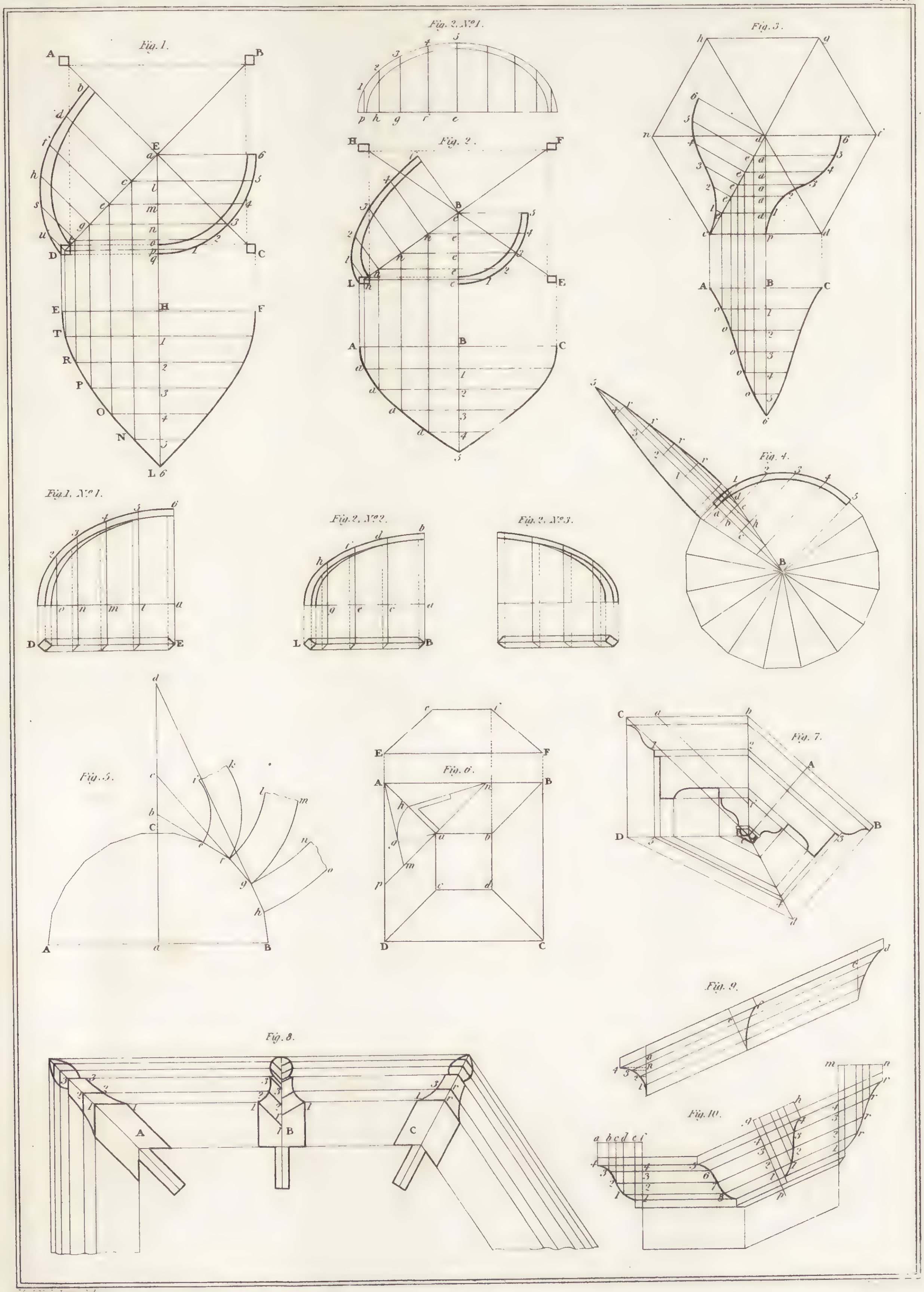
To describe the ribs of a canopy upon a square plan, the section perpendicular to the front being given.

Let A, B, C, D, fig. 1, be the plans of the posts upon which the canopy is supported, and let the given rib be *q* 1 2 3 4 5 6, placed with its base perpendicular to the side D C. The curve *q* 1-2-3-4-5 *b* being of any form required. In this example it is the quadrantal arc of a circle; E *b* being perpendicular to E *q*.

Draw the mitre lines between the inner points of the plans A, C, and D, B, crossing each other at E.

First, to find the angle rib.—In the curve of the given rib, take the intermediate points 1, 2, 3, 4, 5 at equal distances or at pleasure. Draw the lines 1 *t*, 2 *r*, 3 *g*, 4 *e*, 5 *c*, meeting the mitre line in the points *t*, *r*, *g*, *e*, *c*, and crossing the base *p* E in the points *v*, *o*, *n*, *m*, *l*. Draw the lines *t u*, *r s*, *g h*, *e f*, *c d*, E *b* perpendicular to the mitre line on the plan. Transfer the perpendiculars *p* 1, *o* 2, *n* 3, *m* 4, *l* 5 between the base and the curve of the given rib to the

VENEERING, &c.



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perpendiculars *t a*, *r s*, *g h*, *e f*, *c d*, E *b* raised upon the diagonal or mitre line, and through the points D, *u*, *s*, *h*, *f*, *d*, *b* draw a curve which will give the outer edge of the angle rib. The inner edge will be found in the same manner.

Fig. 1, No. 1, fig. 2, No. 2, and fig. 2, No. 3, exhibits the method of backing the ribs of figs. 1 and 2.

The diagonal ribs in fig. 2, are found in the same manner as in fig. 1; but in order to find the form of the covering or cloth upon each side, divide the curve line *e* 1 2 3 4 5 into any number of equal parts, the more, the truer the operation will be; we shall, however, suppose that five parts are sufficient, then extend these parts upon a straight line B 5 perpendicular from the point B to A C, and through the points 1, 2, 3, 4, 5 in the line B 5, draw the lines 1 *a*, 2 *a*, 3 *a*, 4 *a* parallel to A C. Make 1 *a*, 2 *a*, 3 *a*, 4 *a*, respectively equal to the lines *e n*, *e n*, *e n*, &c. between the lines L B and *e* B on the plan which are parallel to L E; and through the points A, *a*, *a*, *a*, &c. draw the curve A *a a a a* 5, and in the same manner draw the curve C 5 on the other side, then A C 5 will be the entire covering of the canopy.

In the same manner the covering A 6 C, fig. 3, will be found, and likewise the spherical canopy exhibited in fig. 4.

These bodies not only exhibit the coverings of canopies, but the figure of a veneer to any square, rectangular, or circular plan.

Fig. 5, shews another method besides that exhibited in fig. 4, for finding the figure of a veneer upon a spherical surface.

Let A B C be a vertical section of the spherical surface. Divide the curve into the equal parts B *h*, *h g*, *g f*, *f e*, &c. Let *a* bisect the line A B. Draw *a* C perpendicular to A B. Prolong *a* C and *h g* to meet each other in *d*, and from *d* with the distances *d h*, *d g*, describe the arcs *h o* and *g n*, and these arcs will be the edge of the veneer, in order to cover the spheric surface of which *g h* is a section.

In the same manner will be found *f g m l*, *e f k i*, &c. the figures of the succeeding veneers.

To find the mitres at the angles of a knife-box.—Let A B C D, fig. 6, be the plan at the top or wide part, and *a b d c* the plan of the bottom or narrow part, A *a*, D *c*, C *d*, B *b*, being the plans of the diagonals, and let E F be the elevation.

Through any point *a* in the plan *a* A of a diagonal, draw *p n* perpendicular to A *a*, meeting the sides A D and A B in *p* and *n*. From the point *a* in the line *p n* make *a m* equal to the height of the elevation, and join A *m*. Draw *a g* perpendicular to A *m*, meeting A *m* in *g*, and from *a* in the line *a* A make *a h* equal to *a g*. Join *h n* by drawing a straight line from *h* to *n*, and *n h a* will be the angle of the mitre required. The same bevel will answer each of the other three mitres, as is evident.

To diminish a cornice in any given proportions.—Let C *b c* be the given cornice, consisting of a fillet *cima-recta*, *corona* fillet, and *cima-reversa*. Upon the height line *b c* make *b f* equal to the height of the required cornice. Join C *c*, and draw *f a* parallel to *c* C, meeting *b* C in *a*. At the point *c* draw the straight line *c* A, making any angle *c* A with *c b*. Make *c* A equal to *b a*, and join *b* A.

Through the points in the height *c b*, where the horizontal lines of the given cornice cut the line *c b*, draw lines parallel to *b* A, meeting the line *c* A. Draw A B perpendicular to A *c*, and make A B equal to *b a*. Draw *c* D perpendicular to *c b*, the height of the given cornice, and from all the points in the projection of the given cornices draw lines to meet *c* D perpendicularly. Draw B *d* perpendicular to B A, and draw *c d*, making any convenient angle with *c* D. Join D *d*, and through the points where the perpendiculars meet *c* D draw lines parallel to D *d* to meet *c d*. Through the points in the height *c b* cut by the horizontal lines, draw straight lines parallel to *b* A to meet the line *c* A. Through the points in *c* A draw straight lines parallel to A B, and through the points in *c d* draw lines parallel to *c* A, and the points where these lines meet will be the points of projecture in the cornice required.

To find the angle-bars of return glass frames.—In fig. 8, B is the given bar, A is an angle-bar placed in a right angle, and C is an angle-bar placed in

an obtuse angle, all the three bars being made to the same thickness. Draw parallel lines to the sides to meet the mitre lines of each angle-bar *w*, two from each point. Take the line I I in A, and make I I in F the section B equal to I I in A, and draw the oblique line I I in B; also in B draw 22, 33, &c. parallel to the oblique line I I; then in the section A make 22, 33, &c. respectively equal to 22, 33 in the given section B, and thus we shall find the curves on both sides of the section A, and in the same manner those of the section C will be found.

Given a horizontal moulding, in a vertical plane, to find the section of a moulding upon the rake to meet the horizontal moulding, and the section of another horizontal moulding to meet the raking moulding on a line parallel to the direction of the horizontal moulding, so that the three mouldings shall be in three vertical planes at right angles to each other.

In fig. 9, let the cavetto 1234 be the given horizontal moulding. Draw lines parallel to the rake, and through the points 1, 2, 3, 4, draw lines parallel to the horizon, meeting the perpendicular line from the lower end of the profile of the moulding. Make the projections of the section at right angles to the rake, equal to those of the horizontal moulding. To find the section or profile of the return horizontal moulding at the top, set the projectures of the horizontal moulding at the bottom upon a horizontal line, and from the points in the extremities of the projectures, draw perpendiculars to the horizon to meet the raking ordinates, and the points where the perpendicular and raking lines meet each other will be in the section of the moulding required.

Fig. 10, exhibits a level horizontal moulding in a plane parallel to the plane in which the raking moulding is, this moulding being connected to the raking moulding by another horizontal moulding in a plane perpendicular to the other two planes and to the horizon.

SPIRAL LINES.

We have now shewn some of the most useful processes which are necessary to the workmen, in order to be able to construct various pieces of cabinet furniture; and though fancy is in a great measure regulated by the eye, the designer must frequently resort to hand-sketching. In this, however, there are many cases in long sweeping lines regularly bending on the same, or in different sides, where he would find it difficult to form such a composition as would be agreeable to the discerning eye, which must be the criterion of every natural line thus produced.

Geometry, which he has found useful in the construction of plans and elevations, and in projection and perspective, will here also be found not only to strengthen his imagination in the designing of beautiful forms, but will even lend her assistance in producing the most elegant curves that can be conceived.

If the human mind were capacious enough to retain a knowledge of mathematical lines of all orders, there is not a curve belonging to any species which would not be of use to the designer of cabinet furniture, as there is not one but what has its peculiar degree of elegance; but since memory is not sufficiently retentive, we shall only introduce such curves as may easily be recollected, and which will be found to be of the most essential service in the art of design. We shall therefore proceed to explain the law of their formation.

THE NATURE AND DESCRIPTION OF SPIRAL LINES.

Definitions.

Def. 1. If round a fixed point another be supposed to move, either continually approaching or continually receding from the fixed point according to a given law, the line thus described is called *a Spiral.*

Def. 2. The fixed point is denominated the centre of the spiral.

Def. 3. The moving point is denominated the *describant.*

Def. 4. If the describant has gone once round the fixed point, the spiral is said to have one revolution; and as often as the describant has moved round the fixed point, so many revolutions the spiral is said to have.

Def. 5. Any straight line drawn from the centre of the spiral to meet the describant, or any point in the curve, is called an ordinate.

Spirals are of many different species, of these the most useful are the spiral of Archimedes, the reciprocal or hyperbolic spiral, and the logarithmic or proportional spiral.

Spiral of Archimedes.

Def. 6. If in the description of a spiral, both the angular space and the distance of the describant from the centre increase uniformly, the spiral is called the *spiral of Archimedes.*

Def. 7. If the construction of a spiral be such, that when the curve is divided into parts by any succession of ordinates making every two adjacent angles equal, and if in any two adjacent angles the separating or dividing line be a mean proportion between the other two, which separates each of these two angles from each of those angles on each side of them, the spiral is called the *proportional spiral,* or otherwise it is called the *logarithmic spiral.*

Therefore, when the ordinates of a proportional spiral divide the space round the centre into equal angles, in every three succeeding ordinates, the third will always be a third proportional to the two first; that is, as the first is to the second, so is the second to the third: as the second is to the third, so is the third to the fourth: as the third is to the fourth, so is the fourth to the fifth; and so on. From the definition and explanation here given, we may find as many points in the logarithmic spiral as will be necessary to construct it.

By means of spiral lines, the designer of cabinet-work is enabled to form these elegant terminations and symmetrical forms which are to be seen in the

various parts of the designs in this work, under the heads of Ornaments, Grecian Ornaments, Elements of Foliage, Chairs, and in almost every species of furniture. In fact, there are very few embellished compositions where such lines cannot be introduced with effect. The characteristic of the Ionic order, and the elegance of the Corinthian capital, are derived from the graceful flowing lines of this species of lines.

In many kinds of curve lines, the curves can only be formed by means of points; this is also the case with the curve lines of the spiral species, and thus to produce a continued line, an infinite number of points would be required; but instead of this unlimited multitude of points, we must be contented with a sufficient number, and either connect the successive points by hand agreeably to the eye, or join them by circular arcs made to the radius of curvature at the points of junction.

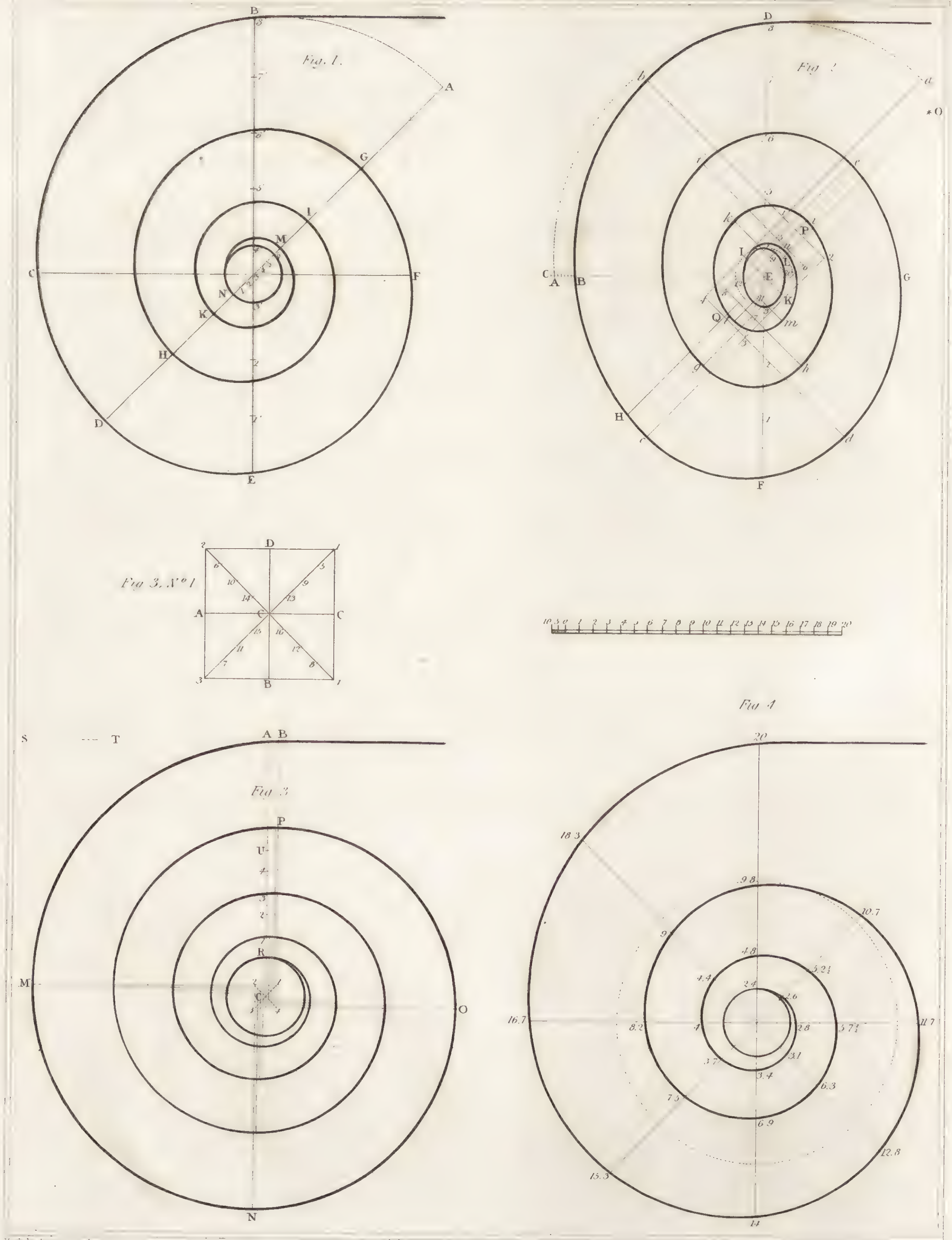
This last is the most eligible method; for though no two parts of a curve taken in succession have exactly the same degree of curvature, yet when the points are not very distant, and succeed each other according to a regular law, the curve formed by means of circular arcs will not differ essentially from the true spiral, and the deviation will scarcely be perceived by the most keen observer.

OF VOLUTES, OR SCROLLS.

Definitions.

Def. 1. A volute is an ornament in Cabinet-work and in Architecture, consisting of two or more spiral lines of the same species of curve. Such ornaments are mostly used in vertical planes, as in the Ionic capital, or in vertical surfaces upon a curved plan, as in the volutes of the Corinthian and Composite capitals. Sometimes in these capitals the volutes, besides their convolution round the centre spring outwardly, being in this case regulated by the surface of a cone, and terminating in the apex of the conic surface as the centre.

Volutes.



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Sometimes, between the spiral lines, the intermediate surfaces are formed into mouldings, as in the Temple of Erechtheus and Minerva Polias at Athens. These mouldings increase the effect of the simple outline of the volute to extreme elegance, particularly when the volute is large in proportion to the diameter of the column.

Def. 2. Cathetus of a volute is a straight line drawn through the centre of the eye, perpendicular to the horizon, to meet the uppermost spiral line.

PLATE XXII.

TO DRAW THE VOLUTE, FIG. 1, THE HEIGHT, B E, BEING GIVEN.

Divide the perpendicular height B E into eight equal parts, the points of division being 1′, 2′, 3′, 4′, 5′, 6′, 7′, proceeding from the bottom upwards. Bisect the distance between the points 3′ and 4′ in the point 3, and from the point 3 thus found as a centre, with the radius 3 3′ or 3 4′, describe the circumference of a circle which will form the eye of the volute. Through the centre of the eye draw the straight line C F perpendicular to B E, and bisect the right angle C 3 E formed at the centre of the volute by the straight line A D.

Divide the part N L of the line A D intercepted by the opposite parts of the circumference, which contains the eye of the volute, into six equal parts. From the point L, with the radius L B, describe the arc B C D; from the point N, with the radius N D, describe the semicircular arc D E F G; from the centre 5, with the radius 5 G, describe the semicircular arc G H; from the centre 1, with the distance 1 H, describe the semicircular arc H I; from the centre 4, with the radius 4 I, describe the semicircular arc I K; from the centre 2, with the radius 2 K, describe the semicircular arc K M, and lastly describe the arc M N; then will the curve line A B C D E F G H I K M N be one of the spirals of the volute required.

A spiral described in this manner, with the centres all in one straight line, is not exactly circular, the outlines being somewhat elliptical. If the spiral had been set upon the line C F instead of B C, we should have had the same curve as that given by W. Newton in his translation of Vitruvius, for the Vitruvian volute. The species of this curve is not of any of the mathematical forms which we have described; its figure makes a rude approach to the proportional or logarithmic spiral, and though not so eligible in the rich orders of Architecture, it may nevertheless be used in many fanciful compositions with considerable effect; the chief thing to recommend it is the simplicity of the operation by which it is described: its application is partial, since it can only be described to a particular point; but to form an elliptical volute, with compasses, of a graceful figure, to any length and height, is a problem which involves considerable difficulty in its construction; we shall, however, give a figure which will approach to the truth of such a method.

PROBLEM I.

To describe an elliptical volute to any given height and projection, from the centre, on one side of the centre very nearly.—

Let D F, fig. 2, be the proposed height. Divide D F into eight equal parts, as before. Bisect the fourth part from the bottom, or the fifth part from the top, in the point E; so that if the whole line F D were divided into sixteen equal parts, the part E F of the line D F below E, would contain seven of these parts, and the part E D would contain nine of the same parts.

From the point E as a centre, with the radius equal to one of the sixteen equal parts, describe the circumference of a circle which will have the same diameter as the eye of the volute. To render the diagram as clear as possible, this circle is described with a dotted line instead of a continued line. Through the centre E draw the straight line C G perpendicular to D F, and draw the straight line O H, bisecting the angle D E G, and intersecting

the dotted circle in the point L: again, through E draw IK perpendicular to OH, intersecting the dotted circle in the points I and K.

In the line CG make EA equal to the projection of the volute, and from the point L, as a centre with the radius LD, describe the arc DA, meeting CG in the point A. Divide BA into six equal parts, and make AC equal to one of the six equal parts, and in OH make LP equal to BC, so that EP is equal to the sum of half the height of the eye and the distance BC. Again, in OH make EQ equal to EP, and through the points I, Q, K, P, describe the rectangle 1 2 3 4, of which the sides 1 4 and 2 3 are parallel to PQ, and the sides 4 3 and 1 2 are parallel to IK. Draw the diagonals 1 3 and 2 4 of this rectangle, and divide each of them into six equal parts. Describe the rectangles 5 6 7 8 9 and 9-10-11-12. Prolong 4 1 to *a*, 2 1 to *b*, 2 3 to *c*, 4 3 to *d*, 8 5 to *e*, 6 5 to *f*, 6 7 to *g*, 8 7 to *h*, 12-9 to *i*.

From the centre 1, with the distance ID, describe the arc *a b;* from the centre 2, with the distance 2 *b*, describe the arc *b c;* from the centre 3, with the distance 3 *c*, describe the arc *c d;* from the centre 4, with the distance 4 *d*, describe the arc *d e;* from the centre 5, with the distance 5 *e*, describe the arc *e f;* from the centre 6, with the radius 6 *f*, describe the arc *f g;* from the centre 7, with the radius 7 *g*, describe the arc *g h;* from the centre 8, with the radius 8 *h*, describe the arc *h i;* from the centre 9, with the radius 9 *i*, describe the arc *i k;* from the centre 10, with the radius 10 *k*, describe the arc *k l;* from the centre 11, with the distance 11 *l*, describe the arc *l m;* from the centre 12, with the distance 12 *m*, describe the arc *m n.*

Thus we have one of the elliptic spirals which will form a part of the volute. Lastly, round the point E, as a centre, describe an ellipse, of which the two axes are in the same ratio as the height of the volute is to its width, so that the axis may be upon the lines DF and CG, and that the same axis major may be equal to the distance E*n*. Then another spiral being described in the same proportions, will complete the volute.

This is a singular example, and it shews what may be accomplished by the powers of Geometry. The joinings are not quite perfect, as the two

adjacent angles at the beginning of every revolution have not their centres in the straight line passing through them and the point of junction.

PROBLEM II.

To describe a volute to any given height, and to terminate at the end of any given number of revolutions in the circumference of a circle whose diameter is given.

Divide the difference between the diameter of the eye and the height of the volute into four times as many equal parts, together with two more parts, as the number of intended revolutions is to consist: that is, if the spiral is to have one revolution, the remainder must be divided into six equal parts; if it is to have two revolutions, the remainder must be divided into ten equal parts; if three revolutions, into fourteen equal parts, and so on; for four times 1 with 2 makes 6, four times 2 with 2 makes 10, four times 3 with 2 makes 14, and so on.

Then take half the number of these parts and one more, together with half the diameter of the eye, and set this distance from the top of the volute downwards, and the lower extremity will be the centre of the eye; or take half the number of those parts made less by one, with half the diameter of the eye, and set this distance on the perpendicular line upwards, and the upper extremity will give the centre of the volute as before.

Construct a square of which the centre is the centre of the volute, and two of its sides are parallel to the perpendicular, and consequently the other two at right angles to each side are equal to one of the equal parts of the number into which the difference between the diameter of the eye and the height of the volute is divided. Draw the two diagonals of the square which will cut each other in the centre of the volute, and divide the half of each diagonal into as many equal parts as the intended number of revolutions are, which will give the centre of the spiral.

Join the point of division, so as to make as many squares with that first constructed as there are to be revolutions, the sides of these squares being

all parallel and perpendicular to each other. The centres of the first revolution are in the vertices of the angles of the first square; the centres of the second revolution are in the vertices of the angles of the second or next square, and so on; the first centre of every revolution being in the same half diagonal, and in the first vertex of every square; every centre is the centre of the quadrantal arc of a circle, terminated upon two straight lines drawn from the centre of this arc, of which straight lines, one is either upon the height line, or parallel to the height line, and the other is perpendicular to the height line.

In describing the spiral, it is obvious, that if we begin next to the centre, we shall continually expand; or if we begin at the most remote point, we shall continually diminish, and at last touch the eye of the volute. It will be preferable to begin drawing the spiral at the most remote point. In beginning the volute, it must be considered whether the volute is to be upon the right or left side; if upon the right side, the first quadrant will have its centre on the left extremity of the upper side of the first square, and this side of the square prolonged from the other extremity will terminate the other extremity of the arc.

In general, the point from which an arc which forms a portion of a spiral is drawn, as also the points in which it terminates, is in a straight line, either in the height line, or in a line parallel to the height line, or in a line perpendicular to the height line of the volute; the point in which any arc begins is in the prolongation of the side of the square from the centre of the arc, and the point in which any arc terminates is in the prolongation of the adjacent side of the square from the remote extremity to the centre.

The methods of describing spirals by means of squares limited to three revolutions, may be seen in the oldest Italian authors; but the generalization of all the known principles of describing spiral lines by means of compasses, was first accomplished by Mr. P. Nicholson, and published in his 'Principles of Architecture, 1796,' as dotted on the Plate.

Example.

Let it be required to describe a volute with four revolutions: let the point C be the given centre. From the point C, with the semidiameter of the eye, describe the circumference of a circle. Through C draw L A parallel to the height line, intersecting the circumference of the circle in the point R. Divide A R into two equal parts at the point U, and divide U R or U A into one part more than the number of intended revolutions, and set one of these parts from the centre each way upon the perpendicular, and the line drawn through the centre at right angles to the perpendicular. Through these points draw the square 1 2 3 4, of which the sides 2 1, 3 4 are perpendicular to, and the sides 2 3, 1 4 parallel to, the height line.

Draw the diagonals 2 4, 1 3, which will intersect each other in the centre C of the circle, and divide each half C 1, C 2, C 3, C 4, into four equal parts, because four revolutions are intended in the volute. Through these points draw squares, of which the sides are parallel to the sides of the first square 1 2 3 4, then 1, 2, 3, 4, are the centres of the outer spiral of the first revolution of the volute 5, 6, 7, 8, the centres of the outer spiral of the second revolution, 9, 10, 11, 12, the centres of the outer spiral of the third revolution, and 13, 14, 15, 16, the centres of the outer spiral of the fourth revolution. These centres are clearly exhibited, fig. 3, No. 1.

Prolong the line 1 2 to M, 2 3 to N, 3 4 to O, 4 1 to P, and so on. From the centre 1, with the radius 1 A, describe the arc A M; from the centre 2, with the radius 2 M, describe the arc M N; from the centre 3, with the radius 3 N, describe the arc N O; from the centre 4, with the radius 4 O, describe the arc O P, and so on, completing the first revolution.

By proceeding in the same manner, we shall find a second series of centres for the second spiral, and thus the volute will be completed.

PROBLEM III.

To describe the logarithmic spiral to any given height, so that the centre of the volute may divide that height in a given proportion.—

Figure 4.

Through the centre of the spiral draw a straight line perpendicular to the height, and find a mean proportional between the two parts of the height, and mark a distance from the centre upon the line drawn through the centre perpendicular to the height, then the extremity of this perpendicular will be a point in the spiral as well as at the extremity of the height. Bisect each of the right angles, and find the bisecting lines a mean proportional between the next two lines, one on each side of it, then the ordinates will be at 45° distant from each other: by this means we have found one half of the first revolution. In the same manner we shall find the other half of this revolution. But if the ratio between any two adjacent ordinates be given, we shall be able to find all the succeeding ordinates; suppose, for example, the first two ordinates are given, 0-20 and 0-18-3, then every third ordinate will be a third proportional to the two given ones; say, as 20 : 18·3 : : 18·3 : 16·7, 18·3 : 16·7 : : 16·7 : 15·3, 16·7 : 15·3 : : 15·3 : 14, and so on, so that by proceeding in this manner we shall have the points 12·8, 11·7, 9·8, &c. and by drawing a curve through them, we shall have the logarithmic spiral, as described.

The arcs of circles may be described through every three given points, so as to form a spiral in the following manner. Take the length of the middle ordination as a radius, then from each extremity of each extreme ordinate describe the arc of a circle to meet each of the extreme ordinates. Thus, in fig. 4, the lines or distances 0-20, 0-18·3, 0-16·7, are three consecutive ordinates; then taking the middle ordinate 0-18·3 as a radius from the points 20 and 16·7, describe an intersection. From this point of intersection, with the same radius, describe an arc 20-18·3-16·7.

Again, 14·7, 15·3, and 14, are the three next consecutive ordinates, the middle one being 15·3, and the extreme ordinates 16·7, and 14. Take the middle ordinate 15·3 as a radius, and from each of the points 16·7, and 14, describe an intersection; and from the point of intersection as a centre describe the arc 16·7-15·3-14, and thus two quadrantal arcs are described, which together form half a revolution of the exterior spiral of the volute: in the same manner the whole outward spiral may be formed

If any point be given in the curve of a second spiral, and in the greatest ordinate, the second spiral may be described to the same proportion in all its ordinates as the first, by saying, as the first ordinate is to the second in the first spiral, so is the first ordinate to the second in the second spiral. Again, as the second ordinate is to the third ordinate in the first spiral, so is the second ordinate to the third in the second spiral, and so on; then when all the points are found, draw a curve which will complete the second spiral, and thus the entire volute, according to the principles of the proportional spiral.

This method of describing the proportional or logarithmic spiral, was discovered by the author of the present work, in the year 1811, for the express purpose of instructing his pupils, and was first published very shortly after in Rees' Cyclopedia; since that time, the method has been copied into several other publications.

A

GLOSSARY OF TECHNICAL TERMS

USED IN

CABINET-MAKING;

WITH A DESCRIPTION OF APPROPRIATE FURNITURE ADAPTED TO THE VARIOUS SPECIES OF ROOMS IN DWELLING-HOUSES, AND OF THE OPERATIONS IN CABINET-MAKING.

ANGLES, in Cabinet-work, are those two surfaces of a piece of furniture which meet and form a corner. See BLOCK.

ANIMAL Forms, were introduced as embellishments into furniture by the ancients: of these we have many Greek examples, both real and chimerical.

ANTE ROOM Furniture, should contain some appropriate sculpture, and a few paintings, with a suitable number of marble tables, with massive carved plain frames, and a convenient number of seats of a simple but elegant form, so as to admit of two or three persons to sit. There might also be narrow tables attached to the walls by hinges, supported by scroll brackets.

ARM-CHAIR, a chair with resting-places for the arms, and hence they are frequently called Elbow-chairs.

B.

BAMBOO, a species of cane which grows in India to a large size. Bamboo is employed in chairs and tables: of this material, bed-room chairs are frequently constructed.

BANDING, is a narrow veneer used as a border, or part of a border, either round the solid wood, or round a large veneer in the centre. When the part surrounded is solid, a rebate must be sunk for the banding. Cabinet-makers employ three kinds of banding. When the wood is cut lengthwise of the grain, it is called Straight Banding; when the wood is cut across the grain, it is called Cross Banding; and when it is cut at an angle between two, it is called Feather-edged Banding. From the various species of coloured woods, a most astonishing variety of elegant combinations may be produced. The grain of the wood at the joints should be well matched.

BASIN-STAND, a piece of furniture placed in bed and dressing rooms, to hold a vessel or basin with water for washing.

BASSO-RELIEVO, a carving in which the projection of figures is less than its real proportion, or less than the true projection, supposing the figures imitated to be of the real size.

BEAD, a semicylindric moulding. Beads are of two kinds; when the moulding touches the surface from which it is made, and the remaining part within the surface, the bead is called a Recess Bead; but when the semicylindric surface of the bead projects beyond the surface to which it is attached, the bead is called a Cocked Bead.

BED-ROOM Furniture, are bedsteads, dressing-tables, drawers, washing-stands, dressing-glasses, clothes-horses, night conveniences; as also various small articles, so well known as not to require enumeration.

BEDSTEAD, a frame of wood or metal, upon which a bed is laid. The metal generally employed in the construction is either iron bars or brass tubes.

BEECH, a hard close wood much employed in chairs, bedsteads, sofas, &c. It is very soon injured by worms.

BIDET, a seat containing a pan of japanned tin or earthenware, most commonly made in the form of a stool, having a loose cover.

BILLIARD-ROOM Furniture, should not have much embellishment; and whatever ornaments may be employed, they should have some analogy to the use of the room.

BILLIARD-TABLE, a table to play at bil-

liards upon. The top is framed with small pannels, and covered with cloth, in order to prevent the whole, or any part, from warping; the pannels ought to be cut so that the annular plates should be perpendicular to the apparent surface of the work.

BLIND, a screen placed on the inside of a window, to prevent the rays of the sun from entering the interior, or persons without from seeing into the room. High blinds, or those that extend the height of the window, are used as sun-blinds; and low blinds are used in parlour windows, to prevent people from seeing the interior or its contents: for that purpose wire gauze fixed in mahogany frames is much used.

BLOCK, a piece of wood glued into an angle where two pieces of wood meet, in order to secure them more firmly than the mere joining of the two parts by glue or otherwise.

BOASTING, is the first process used in carving, by cutting away such of the superfluous parts of the wood as do not require any great attention, leaving the remaining portion for the more minute part of the operation. The carver who is best skilled in the application of drawing is the most fit to be employed in this part of the operation, as he is a better judge of the quantity of sinking that is requisite. The general outline is shaped by the use of saws and gouges.

BOOK-CASE, a kind of press or cupboard fitted up with shelves, at appropriate distances, for the reception of books, maps, prints, and other things adapted to scientific or literary amusement. A book-case may either be a piece of insulated furniture, or fitted up as a portion of the room which is destined for its reception.

The most common kinds of book-cases are made of mahogany, but those of a superior cast are made of oak, with carved roses and other ornaments. Sometimes rose-wood is used, with gilded ornaments, and inlaid with brass.

The shelves of book-cases are generally moulded on the edge, which is also sometimes made of a flat-round, with a brass bead put in the middle. The shelves may either be made to rest on racks, or on round pins of hard wood of about an inch in diameter, inserted on the end about three-eighths of an inch, and projecting as much. The half portion of the pin which projects is cut away, and the other half is let into the other side of the shelf, each shelf being supported by four pins.

Four square-headed brass pins are sometimes used for supporting each shelf, instead of wooden pins, with the square part or head let into the under side of the shelf, the holes for receiving them being in narrow brass plates, the circular part of the pin about one-fourth of an inch in diameter.

The distances and breadth of the shelves must be regulated by the sizes of the books. In order that the same cell or recess may be made to answer to a uniform row of books, all of a given size, the racks and holes for the pins should be adjusted, so as to alter to the required dimensions of the four following species of books, viz. twelves, octavo, quarto, and folio, the extreme sides being

Twelves . .	$7\frac{1}{2}$ in. high, and	$4\frac{1}{2}$ in. wide.
Small octavo .	9	$5\frac{1}{2}$ . . .
Imperial octavo	$11\frac{1}{2}$	$8\frac{1}{4}$ . . .
Small quarto .	11	9 . . .
Imperial quarto	$16\frac{1}{2}$	$11\frac{1}{2}$ . . .
Small folio .	15	$11\frac{1}{2}$ . . .
Imperial folio	23	16 . . .

The lower recess should always be deep enough for the largest folios.

BOOK-CASE DWARF, a book-case, all the shelves of which can be reached without steps.

BORDERS, a display of foliage, fret-work, or inlaying round a plane or uniformly decorated surface. See INLAYING.

BRACKET, a support fixed against a wall, for placing any useful article or ornament upon. The shelf supported by the bracket may either be fixed or moveable by means of hinges.

BRASS, Inlaying with. See INLAYING.

BRASS-WORK, cleaning of. When veneers are inlaid with brass, the brass should be filed level with a fine single-cut file, then rubbed with pumice-stone, next with fine powdered tripola mixed with linseed oil upon a piece of felt or hat, until the desired effect is produced. When the ground is of ebony, or dark rose-wood, the brass may be brought to a better surface with char finely powdered.

BRONZE, a compound metal consisting of tin and copper, used for cast ornaments, &c. The term is also applied to a green colour made in imitation of the colour which this metallic composition acquires by age.

BUHL-WORK, a kind of inlaid work employed in patterns, borders, &c. which took its rise about the middle of the 17th century, and was carried to great perfection in France by the ingenuity of many able artists, among these the most distinguished was the famous Buhl, from whom the name of this species of work is derived.

This kind of inlaying was introduced into other countries, but declined for want of encou-

ragement. It has lately been revived in England, where it has risen to superior elegance, and has superseded those gaudy imitations of animals, fruit, flowers, &c. which were so much employed about ten years ago.

In joining this ornament with that to which it is to unite, the part for the ornament and that for the ground must be glued together, drawn upon the one, and laid upon another such piece joined in the same manner, but placed in reverse order; then the design being drawn upon the one, and the whole substance making one thickness, is cut through by means of a fine bow-saw, thus producing four parts joined in twos reversed to each other.

The plates of brass, or other metal, should be about the usual thickness of a veneer, previously roughed on both sides with a coarse file or smoothing-plane, as also the veneers or other substance to be combined with them. In the act of joining, or connecting them together, the plates and veneers should be previously heated, a thin coat of glue being passed over one of the metal plates, and covered with a sheet of thin paper, coat the paper also with glue, and cover it with the veneer. Pinch them together by means of a screw-press, or otherwise by first placing them between smooth and even boards, to prevent the injury which they would sustain by the pressure. This being done, the work must remain till it becomes dry, the parts will then be found to adhere together with sufficient firmness for cutting the pattern, which should be drawn on the veneer, or, if the lines should not be sufficiently distinct, on a piece of paper pasted on the veneer. The pattern should be cut with a very fine narrow bow-saw, and, in order to join the parts so as to produce two complete ornaments, the one consisting of a veneer inlaid with metal, and the other of metal inlaid with a veneer; place a piece of paper of a sufficient size, with the veneer over it, upon a plane surface, and insert the metal in the veneer with strong glue, rubbing it well down with the veneering hammer and with glue. Cover the whole over with another piece of paper, then having warmed and greased it over with tallow, pinch them by means of a press. When properly dry, the work will separate from the boards; the paper being taken away, it may be laid in its place as a veneer: a caul is usually employed in preference to the hammer. The reverse pattern should be prepared in the same manner. The process is the same whether metal and wood, or metal and tortoise-shell, or two woods of different colours, are employed. When tortoise-shell is used, its under side is sometimes coloured with red, yellow, or some bright colour, and is sometimes gilt.

BUREAU, a desk.

BUST, an imitation of a man or woman downwards as far as the breast, carved of any material, or cast from a mould.

C.

CABINET-MAKING, the art of constructing in wood every species of furniture useful for the conveniences of man.

CABLING, an imitation of the twisted strands of a rope. Flutes are frequently filled with cables, which produce a very good effect.

CADDY, a small box for keeping tea.

CANDELABRA, a candlestick supported from the floor, and used in various situations. Sometimes one is placed at each end of a sideboard.

CARD-TABLE, a table to play at cards upon; the top is generally covered with green cloth, and made in parts so as to fold together.

CARVING, the art of reducing any species of material similar to the form of a given object.

With respect to Cabinet-making, the material upon which this operation is performed is wood. The first part of the work is to form the object roughly, leaving the surface to be completed by a subsequent part of the labour. The first part of the process is called Boasting: the next part of the process consists in forming the principal directing lines, so as to be a guide to the finishing of the work.—In carving valuable wood, the workman must contrive to put the ornament together in parts, so that the joints may be the least visible when the work is complete. The combination of carved and turned works with annular leaves, produces a most beautiful effect, particularly when the turned part is ornamented with flutes or reeds.

CAST, the figure of a required object, formed in a mould by a material in a liquid state.

CASTING Ornaments or Moulding to resemble wood. Make a very clear cement with five parts of Flanders glue, and one part of isinglass, by dissolving the two kinds separately in a large quantity of water, then, after having separated the heterogeneous parts which could not be dissolved by straining them through fine linen, mix them together. The glue thus prepared must be so much heated, that the finger can but only endure the temperature; by this a little water is evaporated, and thus the glue acquires more consistence. Mix raspings of wood, or saw-dust, passed through a fine sieve, with the glue, forming it into a paste. Having rubbed the plaster or sulphur-mould with linseed or nut oil, as in plaster-casts, put in the paste,

and press the parts by hand, so that no vacuity may remain; and in order that the whole may acquire a perfect form, cover it over with an oiled board, place a weight above it, and when the casting is dry remove the rough parts, and if any inequalities remain, they are smoothed; the ornament thus prepared may be fixed with glue to the thing intended.

CASTERS, rollers which revolve round sockets affixed to the legs of tables, chairs, &c. for the more easily removing them from one place to another.

CAUL, a kind of mould, made of solid wood, used in veneering; it is formed to the surface to be veneered, and having been well heated, oiled, and greased, it is screwed down upon the veneer, and its heat and pressure forces the glue out of the joint, and therefore causes the veneer to bed closely upon the ground. Cauls for curved surfaces are sometimes made of thin wainscot; being heated, they are made to bend to the surface. Cauls for card-table tops are generally made of inch deal, and keyed across with wainscot, to keep them straight.

CEDAR, a name given to two kinds of wood; the one, which has a very strong scent, is called Pencil Cedar; the other is similar in appearance, but without any perceptible smell.

CELLARET, a wine-cooler, or wine-cistern. The most convenient situation for a cellaret is under the centre of a sideboard when it is not in use. The smallest size should be made to hold nine bottles, and for larger rooms the dimensions of the cellaret may be increased so as to hold twelve or fifteen bottles. The depth should not be less than 13 inches, and the space for each bottle is usually $3\frac{1}{2}$ inches square.

CEMENT-STOPPING, a composition made with clear glue and fine saw-dust, used for stopping up the holes or defects of hard wood. When the surface is to be painted, whiting may be used instead of saw-dust; and the stopping must be allowed to be thoroughly dry, before any attempt can be made to finish the surface.

CHAIR, the well-known article for sitting and resting ourselves upon.

CHAIR-MAKING: the tenons should always be in the direction of the grain of the wood; and as the framing is of a trapezoidal form, the mortises should be made obliquely, to receive the tenons; they are easily put in a vertical position, by means of a proper saddle made to the bevel: the greatest care should be taken that the sides of the mortise and the sides of the tenons should be parallel, and as exactly fitted to each other as possible; by this means, when the parts are properly glued, and the work is forced together by means of a cramp, the parts will unite in the strongest manner.—In chair-making, the beauty of the work depends on correct forms of the curves and scrolls, and in being agreeable to the eye.

CHAISE LOUNGE, a kind of sofa.

CLEANING of Work, is the art of reducing the surface to the required degree of smoothness. The finishing of the surface of work is also called Polishing.

To clean the surface of solid work—Smooth it by means of a finely set smoothing-plane, and reduce the ridges by a scraper; then rub the surface with glass paper, finishing it with the finest kind: but if the grain of the wood be open, we must proceed farther in addition to the process now described. Let the surface be uniformly wetted with a wet spunge, and when it becomes dry, rub it a second time with glass paper, till it has acquired the requisite degree of smoothness.

This last or additional part of the process might have been accomplished in the following manner. While the surface is wet, rub it with a piece of pumice-stone in the direction of the fibres; and when it becomes dry, wet it again, and the grain will be raised in a much less degree than in the former wetting; then the process of rubbing being repeated, the surface will be found to be still more compact, and will therefore receive a better polish.

To clean a veneered surface—Having taken or scraped away the glue, tooth the surface in an oblique direction to the fibres, and in proportion as the surface acquires a regularity, set the plane finer. The final part of the operation of planing is accomplished by a finer tooth-plane. Remove the marks of the tooth-plane by a scraper, and finish the surface with glass paper, or pumice-stone and glass-paper. Veneers, being of a closer texture than solid wood can always be found, do not require so much labour as open-grained solid wood.

To clean veneers laid with brass—File the brass level with a fine single cut file, and then rub it over with pumice-stone, next with fine powdered tripoli mixed with linseed oil, until the desired polish is acquired.

CLEANING old Furniture, is the art o giving the surface an appearance of newness or at least of freshness, which may be accomplished by means of the following operation:—

When furniture has been finished by means of the French polish, grease or dirt may be removed from the surfaces by rubbing it quickly over with a little spirit of turpentine, which will not soften the varnish.

When furniture has been finished with wax composition, the polish may be renewed by repeating the original process of the wax composition with a small quantity, carefully rubbed off.

To remove stains in tables—Wash the surface over with stale beer or warm vinegar, and the stains will be removed by rubbing them with a rag dipped in spirits of salt, then the surface may be repolished in the same manner as new work is done.

When the work is not stained, wash the surface with clean spirits of turpentine, and repolish it with furniture oil.

To clean lacquered brass-work in furniture—Wash it over with a soft linen or muslin rag wetted in warm water; and if the spots cannot be removed by this method, they must be relacquered.

COLOURED WOODS, are those which have a natural colour, or such as may be produced by the process of dying. Wood of the natural colour is always the most valuable; but as it can never be obtained in sufficient quantities to form large surfaces without striking defects, a combination of different coloured woods, or of metals and shells with woods, has been resorted to. These combinations are effected by coloured bands and ornaments of wood, or by beads, lines, or ornaments of brass, which are frequently enriched by engraved lines on the surface. In such combination, care must be taken to harmonize the colours, so as to give sufficient relief.

There are three primitive colours by which all the colours in nature may be produced; these are red, yellow, and blue. Green is produced by the mixture of yellow and blue, orange by the mixture of red and yellow, and so on.

Every two colours in the six following, which produce the most opposite effect, may be found thus—Divide the area of a circle into six equal sectors, by straight lines drawn from the circumference to the centre; then suppose the first to be made blue, the third red, the fifth yellow, then the second will be purple, the fourth orange, and the sixth green; and the colours which are in opposite sectors are those which are the most opposed to each other in their nature: thus, orange being opposite to blue, have the most opposite quality; and it is worthy of observation, that the intermediate colour between two adjacent primitive ones, is the composition which arises from their mixture; thus, between yellow and blue we shall have green, between blue and red we shall have purple, and so on.

Again, by various combinations of the six colours thus produced, an infinite variety of gradations may be produced. If any two colours in opposite sectors be mixed, a neutral tint or brown will be the result; thus, orange and blue make brown, purple and yellow make brown, red and green make brown.

The illustration of the theory of colours may be farther extended, by forming three equal sectors of circles, of which the sides or radii are the sides of an equilateral triangle, the arcs being described from the vertices, so as to meet every two sides of the triangle, and to divide its area into seven parts, of which one will be in the centre: then if the three entire sectors be painted with the three primitive colours, the intermediate one upon each side of the triangle will be the colour which arises from the mixture of those in the two adjacent quadrilaterals, which terminate the angles of that side; and the colour in the trilateral figure which occupies the centre, being that which is produced from mixing the three together, is brown.

Painters divide colours into warm and cold; the warm colours are yellow, orange, and red; and the cold colours are purple, blue, and green. In each class of colours the middle one is that which has the greatest intensity; therefore in the three warm colours the orange is the warmest, and in the three colours the blue is the coldest.

We shall only remark, that when any rich colour is applied, very little variety need be introduced; but if the colour be light and delicate, the addition of others will be desirable in order to give a more lively effect by contrast, which, being skilfully managed, will give force and lustre to the ground; but, on the contrary, opposition would entirely destroy its natural harmony.

It is of the greatest advantage to the cabinet-maker to have a clear idea of the result arising from the combination of two or more colours, in order to give the best effect to his work, and to avoid incongruous associations of them.

COMMODE, a low wardrobe, or a piece of drawing-room furniture, of which the lower part is often enclosed with doors, and the upper part is furnished with book-shelves.

COMPOSITION ORNAMENT, is a species of ornament made of whiting and thin glue of the consistence of glaziers' putty, and pressed into a mould which has been previously oiled with sweet oil. It is then taken out, and if applied upon a plane surface, it is suffered to dry; but if applied upon a curve surface, it should be bent while it is soft, to the proper form.

CONSOLE, an ornament with a double scroll one turning inwardly and the other outwardly, for supporting a cornice. Consoles are also used as modillions.

CONSOLE TABLE, a table supported at the wall upon consoles.

CONTOUR, the most extreme boundary of a body.

CONTRAST, the difference of colour, or figure, or proportion.

CONVERSATION CHAIRS, those that are made to keep the body in an easy posture during conversation. See the various designs in this work.

COPAL, a varnish made of the juice of an American tree: it is a concrete, hard, shining, and odoriferous; the colour is transparent, like that of citron. This substance is such as will neither dissolve in spirit of wine nor essential oils, except by a certain process. It may, however, be dissolved by digestion in linseed oil. Copal varnish is superior to any other.

CORNICE, an ornament consisting of one or several mouldings situated at the top of a piece of furniture.

COUCH, a long seat on which persons occasionally lie down to rest.

D.

DECORATION, every species of ornament is called a decoration.

DEFECTS, are those parts of a piece of wood where the material is wanting, as a hole, shake, or the like.

DESK, a piece of furniture so constructed as to make it convenient for writing upon, and to contain small articles and valuable papers. Those boxes used by travellers for writing upon, consisting of two parts hinged together, are called Portable Desks.

DINING-ROOM CHAIRS, are of course those chairs adapted to the use of dining; their construction and ornament should depend on the character of the architectural finish displayed in the embellishments of the room.

DINING ROOM FURNITURE, should, as we have observed in chairs, depend on the species of architecture introduced. As the walls cannot, in the Grecian style, admit of being entirely covered with architectural ornaments, a few plain portraits may be introduced in the large spaces.

DINING-TABLES, those used in dining-rooms. Dining-tables are of various kinds; some have frames and legs, and others have pillars and claws: those with legs have the advantage of being steady, and made in parts, so as either to be extended or contracted at pleasure. Tables with pillars and claws are more elegant than those constructed with frames, and in the act of dining they are entirely free of the sitters at table; whereas in the other the legs are in the way; but they are much more expensive in point of workmanship. Dining-tables should be about 28 inches in height. The tops of dining-tables are exposed when the dessert comes to be set: the wood should be uniform in its texture, even, and hard; Spanish mahogany is very well adapted to the purpose.

DOVE-TAILING, a mode of framing two parts together by means of prismatic pins, and recesses cut in their right section in the form of dove-tails, so as to leave no open space between the joints. There are several kinds of dove-tailing, as common dove-tailing, lap dove-tailing, and mitre dove-tailing, used on different occasions.

DRAWERS, a deep frame consisting of several shelves or partitions, with sliding-boxes called Drawers, open at the top for holding linen, ladies' dresses, &c. The drawers, as well as the frame or drawer-case, are always dove-tailed.

DRAWING-ROOM, or Withdrawing-room, a room in which company collect before dinner, and to which they retire after. It is appropriated to the reception of company and formal visits; hence the style of the furniture should be elegant. The plain surfaces of the walls are frequently embellished with large glasses upon the solid parts between the windows, and still more generally over the chimney-piece. The more extensive surfaces should be ornamented with a select choice of paintings adapted to the size of the room.

The furniture of drawing-rooms consists of commodes, pier-tables, fire-screens, vases, bronzes, tables, sofas, couches, chairs, seats, foot-stools, loo-tables, &c. Drawing-room tables are made of the best mahogany, the most richly figured British oak, rose-wood, &c.; sometimes foreign woods are employed; the tops are frequently inlaid with brass in ornamental borders.

DRESSING-ROOM FURNITURE, such furniture as is appropriate to the use of the dressing-room. This may consist of drawers, dressing-table, writing-tuble or secretary, cabinets, sofas, chairs, stools, wardrobe, &c.

E.

EATING-ROOM FURNITURE, should be side-boards, dining-tables, chairs, side-tables, waiters, &c. The decorations and style of the furniture should be more plain than those of the withdrawing-room.

EBONY, a fine compact wood, much used in mouldings which surround pannels.

ENTRANCE HALL, a room or passage used for waiting. The furniture should consist of marble tables and a convenient number of seats and chairs.

The chairs of entrance halls usually have the crest of the owner. The seats and chairs are generally made of the same material, and are often constructed of oak. The frames of the marble tables should be massive, and they may be either plain or carved. The style of the furniture should bear some analogy to that of the other rooms.

F.

FLUTES, a series of equal hollows sunk into a plane, or cylindric, or conoidal surface. The right sections of flutes are most commonly semi-circular or semi-elliptic arcs. When they are applied to a conic or a conoidal frustum, they are made to diminish in proportion to the circumference of the body at every part of its extent or height. Flutes sometimes come in contact with each other, and sometimes a portion of the surface from which they recede remains between them; these surfaces are called fillets, and are generally much less in breadth than the breadth of the flutes. The objects to which flutes are applied are turned legs of tables, chairs, &c. When flutes come in contact with each other, the circular or elliptic must be always less than a semi, as it would be impossible to preserve the arris; but though a sharp arris is the perfection of the workmanship, it is frequently taken away in order to preserve it from injury.

FOLIAGE, ornaments consisting of leaves, fruit, flowers, frequently connected with stalks, making agreeable turnings in lines of contrary curvature, and terminating in elegant spiral lines.

FOOT-STOOLS, those for placing the feet upon in order to give greater ease to the person who sits.

FRENCH POLISH, is a new and durable mode of polishing or varnishing, by which means it is not so much necessary to polish the surface of the wood itself. This mode consists in applying a considerable thickness of transparent gum-lac over the surface, so that the surface of the gum appears as if it were the surface of the wood.

This polish is a kind of spirit-varnish, consisting principally of shell-lac dissolved in spirits of wine; and in order to render its colour paler, it is mixed up with gum-mastich and gum-sandarach in the following proportions:—Shell-lac, 3 parts; gum-sandarach, 1 part; gum-mastich, 1 part; spirit of wine, 40 parts.—The gum-sandarach and gum-mastich must be first dissolved in the spirit of wine, and the shell-lac next. Put these in a bottle loosely corked, and place the bottle in a vessel of water heated to the boiling point of spirit of wine, or a little below 173°, until the solution is effected.

The surface to be polished should be placed opposite to the light, in order that the effect produced by the polishing may be better seen; prepare a rubber formed of the flat coil of thick woollen cloth torn off the piece, so that the face of the rubber formed of the torn edge may be soft and pliant; then, after having rolled it into form from one to three inches diameter, secure it with a thread coiled round it. The face of the rubber being covered with a soft linen cloth doubled, the remainder of the cloth at the other end of the rubber forms a handle to hold it by. The face of the cloth must be moistened with a little raw linseed oil, and, if required, may be coloured with alkanet-root, applied upon the finger to the middle. The varnish is enclosed in the double fold of the cloth. Then rub over the surface quickly and lightly in circular directions, confining the operation to a space not exceeding ten or twelve inches square, until the area is gone over, and until the space is nearly dry. Proceed in this manner with equal areas or portions, until the whole surface has been gone over: the operator must be careful to join every two adjacent surfaces.

In giving the surface a second coat, the rubber may be moistened with the varnish without oil, and applied as directed. A third coat may be laid on in the same manner, and then a fourth with a little oil. The process must then be repeated in a similar order, viz. with two others without oil, and so on, repeating the coats until the varnish has acquired its proper thickness. Then the inside of the rubber being moistened with a little spirit of wine, and having wetted it with the varnish, rub the surface quickly and uniformly over every part, which will greatly contribute in giving it uniformity, and the polish required. Next wet the cloth with a little spirit of wine and oil without varnish, and rub over the surface until it is nearly dry; then the effect of the operation will shew whether the process is complete or not; if not complete, the operation must be repeated.

FURNISHING, Styles of. The style of Furnishing ought to correspond to the style of architecture of the building, and more particularly that of the rooms in which the furniture is placed. The style may, therefore, be Egyp-

tian, Greek, Roman, Gothic, &c. We have also modern styles, as French and English. In point of form, French and English furniture has each a peculiar character; but with respect to decoration, the ornaments are imitated from the ancient Egyptian, Greek, or Roman. There is no style of architecture that affords such a variety, and so many elegant forms, as the Greek. The articles of furniture were, however, not very numerous among the Greeks; they consisted chiefly of couches, chairs, tables, tripods, and vases; and have been chiefly collected from Winkelman, Count Caylus, and Stewart. From the examples thus found Mr. Hope formed a complete system of Cabinet furniture. But though the articles of Greek furniture were not very numerous, the variety of ornaments which their architecture have presented has afforded the means of producing a multitude of elegant forms and splendid embellishments. The couches of the Greeks were of different forms; the plan was sometimes three sides of a square, and sometimes a semicircle; the legs were often formed into elegant shapes, and occasionally highly ornamented.

The seats of the Greeks were adapted for one or more persons; those intended for more than one were probably used for conversation, as they were often of a semicircular form, which was extremely convenient, as it brought the persons opposite to each other. The table was so situated as to be surrounded on three sides by the couch.

In religious ceremonies, tripods were sometimes used; and a brazier, for warming the apartments, was generally supported by a tripod or stand. These tripods were generally of an elegant form, consisting of three legs supporting a ring to receive the brazier. The legs were sometimes formed in the shape of the legs of animals; other decorations, as paws, heads, &c. were also used.

Of all the kinds of furniture, the Greeks bestowed the most splendid ornaments upon their vases. Of these vases some were used for domestic purposes, others contained the ashes of the dead, others were for ornament; but to whatever purpose they were destined, they were generally formed of the most elegant figure, and decorated in the most splendid manner.

The ruins of Herculaneum and Pompeii have recently furnished us with numerous examples of the Roman style. The tops of the tables of the Romans were sometimes supported by a pillar, with a flat base or pedestal; others by a pillar rising from a base supported upon three or four low turned feet. The legs sometimes stood on a flat base, which was frequently raised with turned feet and the claws of animals.

The furniture of the Romans was of a similar description to that of the Greeks, but was greatly inferior in point of form and decoration; they, however, bestowed great attention on the form and embellishment of their candelabra, which were sometimes six feet in height.

The style of Egyptian furniture may be chiefly collected from Denon, who travelled in the Egyptian expedition with Buonaparte.

G.

GALLERY FURNITURE consists of seats to admit of two or three persons, narrow tables supported by scroll brackets, &c.: the walls are decorated with the paintings of the great masters.

GERMAN STYLE of Carving, is a combination of fantastic chimerical subjects, introduced by the Germans, but now antiquated.

GILDING, a glittering surface made by means of gold leaf. In order to produce a golden effect, the parts to be gilt should be chosen with care, and not over-abundant, which would produce a tawdry effect.

GLUE, a strong cement for wood, made of the skin, ears, &c. of animals; first formed into hard cakes, then steeped in water until all the parts have become soft. It is then dissolved by heating it in water; and while in the fire, it should be carefully stirred, to prevent it from sticking to the vessel or glue-pot, until the water boils and the pieces of glue are thoroughly melted. The joints to be glued must be perfectly close, so as to prevent seeing between the surfaces, which ought to come in contact, though the work may be opposed to the light. The hotter the glue is, the more force it will exert in keeping the two parts together; therefore, in all large and long joints, the glue should be applied immediately after boiling. Glue loses much of its strength by being often melted; therefore glue that is newly made is preferable to that which has been used.

GOTHIC FURNITURE, is that which is constructed in the Gothic style, in order to correspond to the style of architecture of the room where it is placed.

GREEK FURNITURE, is not only such as has been used by the ancient Greeks, and which has been transmitted to the present times by means of the sculpture of their architectural edifices; but all sorts of furniture, whether used by those ancient people or not, that is decorated by Grecian ornaments.

GROOVES, are those channels which are sunk into the substance of a board or other work, in order to insert the edge of another

board or piece of work, so as to fasten the two boards or piece of work together. Grooves are of two kinds, viz. either plain or dovetail. Dovetail grooves are those that are wider at the bottom than at the surface to which the work is parallel; by this means the piece or board which has its inserted edge cut in the same form, cannot be drawn out by any force acting perpendicularly to the surface of the other board into which it is inserted, without breaking the edge; but can only be taken out before it is glued in the direction of the groove.

GROUPE, a collection of individual things, as a groupe of figures, &c.

H.

HALL FURNITURE, in splendid houses, may consist of marble tables with massive frames, and a convenient number of chairs and seats, which ought to be decorated suitably to the rooms to be entered. In grand mansions, the walls may be embellished with paintings, and the interior furnished with a sufficient quantity of appropriate sculpture.

I.

INLAYING, an expensive mode of ornamenting furniture, by inserting other materials of a richer colour, or better quality, either of natural or dyed woods, metals, or shells.

The art of inlaying is very old. It was practised in ancient times by the people of Asia. These nations were subdued by the Romans, who imitated and acquired the art from the spoils of the cities which they had conquered; and from the Romans, the nations of modern Europe received their instructions, and became expert proficients in the art.

JARDINIERE, a support for a small room-garden, a flower-stand.

K.

KEYS, very thin slips of wood let into saw-kerfs, and fixed with glue at the angles where two parts of a piece of work are joined together. These slips should not be in parallel planes, but should incline towards one another in the manner of dovetails.

L.

LADIES' DWARF WARDROBE, a wardrobe for ladies, lower than the room in which it is placed.

LAP DOVETAILING, is a species of concealed dovetailing, where the front is made to lap over the side, so that the end of the wood of the front piece is exhibited as if it were in the same surface as the return part.

LIBRARY FURNITURE, may be of a similar description to that of the drawing-room; but the decorations may be of a plainer kind.

LOO-TABLES, are contrived so as to be convenient for playing at the game of loo,

M.

MAHOGANY, a well-known species of foreign wood, much used in common furniture. Logs of mahogany may be cut into planks of such amazing breadth, as to afford table tops of immense width.

Mahogany is of several species, which have different degrees of hardness; some are as soft, and may be as easily wrought, as deal; other kinds are hard and compact, and cannot be made smooth without the use of the scraper. One sort comes from Jamaica, another from Yucatan, called Honduras Mahogany; but that of Jamaica is much more durable and beautiful, and appears as if the pores were filled with chalk. In furniture, when first made, it is of a light yellowish colour; but it darkens and reddens gradually with age.

MITRE DOVETAILING, is a joint in which the strength consists in the dovetailing, but which only exhibits a plain mitre, the dovetailing being concealed.

MODILLION, a kind of console. See CONSOLE.

MORTISING, in the construction of cabinet-work, is the method of cutting prismatic recesses in one part, in order to receive another in a different direction, and to join and fix them together, so as to become one undivided whole, or part of a whole, if again to be connected with other parts. The part which fills the mortise is called a tenon. It is obvious that the less the cavity between the mortise and tenon is, the more firmly will the glue unite the two parts together; therefore the mortise must be very exactly cut, and the tenon nicely fitted.

MOSAIC WORK, inlaying with coloured marbles. The tops of tables are often beautifully ornamented with Mosaic work.

MOULDINGS, a prismatic surface, of which the profile consists of a series of curves and straight lines. The profiles of Grecian mouldings consist of all the curves of the conic sections, but more particularly that of the ellipse, under varied proportions of the axis; and those profiles of mouldings used by the Romans consist only of the arcs of circles, and therefore do not produce that pleasing variation of light and shade which Grecian mouldings afford. The profiles of Gothic mouldings have a much nearer affinity to those of the Greek than to the Roman, as the degrees of curvature are much more varied; but there are certain peculiarities of ridge-lines in the meeting of Gothic curves that are characteristic of their species.

MUSIC-ROOM FURNITURE, is that which

ought to be adapted to the character of the Muses. The embellishments should, therefore, be emblems of music, antique instruments, &c. and the furniture should have considerable affinity to that of the drawing-room.

O.

OAK, a species of wood of a rich umber-brown colour. The wood of old trees with excrescences, stunted trees of a slow growth, and pollard trees, have been much used in furniture, from the richness which the surface presents when polished. The deep-coloured woods are well adapted for moulding, as the contrast between the ornamental and plane parts has a fine effect.

OLD ENGLISH FURNITURE, that which is made to imitate the style of furniture used in the old Gothic mansions. We must, however, observe, that the Gothic furniture which is now so much used, is that which was constructed in the decline of cathedral architecture, and is a composition of ecclesiastic and castellated architecture. It was introduced during the reign of Elizabeth, and is easily recognized by an ostentatious display of fantastic decorations. The peculiar embellishments should be taken from the screens, niches, canopies, pews, seats, and monuments of ancient cathedrals and churches.

ORNAMENTS, are all those embellished parts of furniture which vary from smooth or polished surfaces, in order to produce an agreeable succession of parts. Ornaments may consist of various combinations of surfaces, as in Mosaic works, carvings in imitation of animals or foliage, and mouldings of every form, or any combinations of those which will be productive of good effect.

Furniture is sometimes constructed, so that every visible part is covered with ornament; but, as proportion and relief are necessary, the planes or general curved surfaces which form the design, should be embellished with a repetition of some beautiful figure, in order that the whole may appear to advantage; and as it is light and shade that produce relief, care should be taken to give carved work and mouldings their proper projections.

The composition of ornaments is best acquired from the study of the works of antiquity, as no written rules can ever direct the taste of the artist in this field of display; and his talent must be acquired by long practice in the effect of various combinations.

OR-MOULU, a species of gilding by means of mercury, which produces a fine spotty brilliancy to very plain wood-work. This process is accomplished by means of leaf-gold, of which the leaves are thicker than those used in other kinds of gilding. Having cleaned and freed the surface from the acid used, cover it with an amalgam of gold and mercury, spread on with a brush of brass wires, which being done, cover it with a double coat of leaf-gold, pressing it close with a piece of cotton, in order to prevent the gold from collecting in hollows; next place the work in such a manner as to permit the mercury to escape, and let it remain for about an hour, until it is entirely drained; then place it over a charcoal fire for about a minute or two, turning it until it becomes bright; having taken it from the fire, strike it with the wire-brush, in order to drive the gold into the receding parts: place it again on the fire for about two minutes, until the mercury evaporates, and leaves a colour like that of box-wood: having cooled and washed it in water, apply the amalgam of mercury a second time, and a third, if necessary, but without the leaf-gold. To remove the box-wood colour, brush the work with a wire-brush in a weak solution of vinegar, and rub it over with a linen rag; put it upon the fire on an iron grate, and permit it to dry; having covered it with a saline powder, and having again put it over the charcoal fire for about half a minute on each side, wash, and dry it in the air, and lastly make completely dry over the charcoal. It is from this species of gilding that French furniture derives its brilliancy.

OTTOMAN, a seat in the form of a sofa, a kind of footstool.

P.

PATENT DINING TABLES, tables which may be extended into different lengths by means of leaves concealed in a case under them. The patent has now expired.

PATERAS, or Rosettes, ornaments made in imitation of roses.

PEDESTAL, the lower support of an order, applied in cabinet work to side-boards, either forming parts or insulated.

PUMICE-STONE, a very porous kind of stone, used for polishing the surface of a piece of wood which is not very close-grained. This is done by spunging the surface with water, and rubbing it while wet with a flat piece of fine pumice-stone, in the direction of the grain, and permitting the wood to dry, and again repeating the operation of wetting, rubbing, and drying. By this means the surface will be found much more condensed, and will have acquired the desired degree of smoothness, by attentively observing the effect in every stage of the progress during the operation.

R.

REEDING, a series of cylindric or conical staves, arranged upon any surface, but more particularly round the surface of a cone cylinder, and in this application they appear like a bundle of rods.

ROMAN FURNITURE, is that which is constructed in imitation of the Roman style. The information required in the execution of this style is chiefly collected from publications which exhibit, in plates, representations of the ruins of Herculaneum and Pompeii. The most splendid article of furniture used by the Romans were their Candelabra. Their tables were generally sustained by a pillar, some having a low pedestal, others with a base supported by three, and sometimes four short turned legs, or ornamented with the paws of animals. In the decoration of Roman furniture, chimerical figures were used in very great abundance; garlands and festoons were also employed occasionally. In point of taste, the Roman furniture was stiff, and often too much overcharged with ornament; it wanted the fine-flowing outline, simplicity, acd chastity of Greek furniture.

ROSE-WOOD STAIN, a stain given to chairs, sofas, and the like, constructed chiefly of beech, in order to produce a similar effect to that of rose-wood. For the process, see STAINING.

S.

SALOON FURNITURE, ought to be of a similar description to that of halls and galleries.

SCRUTOIRE, a case of drawers to contain writings.

SEAT, a bench adapted for sitting upon. Under this general term are included chairs, sofas, couches, but it is more particularly applied to a kind of form. Stools are small narrow seats without ledges.

SECRETAIRE DESK AND BOOK-CASE, a convenient repository for writing, keeping valuable papers and choice books in, &c.

SHRINKAGE, a contraction of wood in a transverse direction to the fibres, which takes place in expelling the natural sap.—No work will stand unless the wood has been sufficiently seasoned; for if thus not properly prepared, the joints will be liable to loosen, the surfaces will be in danger of warping and splitting, by which means the strength of the work and the beauty of its appearance is destroyed.

SIDEBOARD, a piece of furniture used in a dining-room, for containing such articles as are employed in the use of the table; their height is generally about 37 inches, and their breadth from 30 to 33 inches; their length depends upon the size of the room, and may extend from 5 to 10 feet. Sometimes they are constructed with cases for holding wine; but when of a large size, the celaret, or wine-cooler, is most convenient when separate, and its situation is generally under the middle of the length of the sideboard.

SIDEBOARD, RUNNING, a sideboard with supports for table articles at various heights.

SOFA, a seat or couch on which several persons may sit at once, or on which one person may sit or lie down, as may be found most convenient.

SOFA-TABLE, a long table to stand before a sofa.

STAINING, is a method of imitating various species of wood by dying the surface. This effect is chiefly employed in chairs, sofas, and bedsteads, and when done, the surface is polished and varnished. The woods on which this operation is performed are holly, pear-tree, and beech.—An Ebony stain is effected by a mixture of galls and logwood in the proportion of 12 to 2, by giving the surface one coat; again, by adding one part of verdigris to the mixture, give it another; then adding one part sulphate of iron, apply another; and repeat this operation, if necessary.—Rose-wood may be imitated by a mixture formed in the following manner: Boil 16 parts logwood in 64 parts water, till the liquor acquires a deep red colour for the ground; then having added one part potash, apply the hot mixture to the surface; repeat the operation of coating, till the required rose-wood ground is acquired. In order to granulate the surface, heat the ebony stain before described for the last coat, and with a graining-brush, like that used by painters, mark the dark veins on the surface of the work in imitation of the streaks of the natural wood.—To imitate Mahogany, rub the surface with a diluted solution of aqua-fortis; dissolve by heating one ounce of dragon's blood in a pint of spirit of wine, and add one ounce of carbonate of soda to the mixtnre, which being filtered, lay it on with a soft brush in two coats, and the surface of the wood will have the appearance desired.—The same effect is, however, produced at a less expense, by rubbing the surface with a diluted solution of aqua-fortis, and then, if the article is small, it may be heated upon a fire, but if large, it must be placed in an oven, and covered with hot sand.—Another method of imitating Mahogany is by mixing Indian red with a small proportion of yellow-ochre, which ought to be varied to answer the grain and colour of the wood.—Oak may be imitated by a due proportion of umber and yellow-ochre.

STAIRCASE FURNITURE, should be of a similar description to that of halls, galleries, ante-rooms, &c.

STOPPING, a method of making good the defects in fine work, so as to render the surface continuous, by stopping up the cavities with fine saw-dust formed into a paste with clear glue. If the surface is to be painted, the work should be first primed: in this case whiting may be used instead of saw-dust; and when the composition is dry, the protuberant part may be taken away, and the surface smoothed; but putty should never be used when the defects are extensive. Defects are also stopped with a composition made to imitate the colour of wood, consisting of resin and bees-wax; the colouring matter is then added. These may be respectively in the proportion of 1, 4, 1, the entire composition being 6.

Another composition may be made by grinding the required colour in spirits of turpentine to the consistence of a thick paste; and having softened this paste with turpentine-varnish, stop the defects with it, then cause the turpentine to evaporate by putting it in a warm place; and when it has remained about a day, the stopping will be very hard, and will have the advantage of not being softened by heat.—The stopping used in common work is glazier's putty, mixed with colour to imitate that of the wood.

T.

TABLE, a well-known piece of furniture for containing food, writing, or any other articles on its surface, so as to be convenient for the purpose intended, without obliging those persons who surround it to stoop. The height should be just sufficient for a person sitting near its edge to rest his arms without suffering any inconvenience.

TEA POY, a tea chest supported upon a pillar, with feet of various forms.

TENT BEDSTEAD, a bedstead in the form of a tent.

TRACERY, the ornamental divisions between pannels in Gothic architecture.

TRIPOD, a seat with three legs. This was used by the Greeks for supporting a kind of bason called a Brazier, which contained fire for warming their apartments.

TRIPOLI, a soft silicious stone, of a gray colour inclining to yellow, used for polishing wood, metal, stones, varnish, and glass.

V.

VALANCE, narrow drapery hanging round the cornices, testers, steads, and curtains of beds, and also accompanying window-curtains to give them a fulness and completion.

VARNISH, a kind of liquid, which, being applied to the surface of wood, becomes extremely hard, produces a beautiful shining lustre, and gives the effect of a very high polish.

VASES, an ornament in the form of a solid of revolution with its axis vertical. Vases were anciently used as an article of furniture by the Greeks. We cannot now ascertain to what use these vases were applied. Their contour was exceedingly graceful, and was much varied in its outline, and their surfaces were highly decorated with the most delicate and fine ornaments.

VENEERING, a method of covering the surface of a piece of wood called the Ground, with a thin plate of wood called Veneer, so that the two surfaces may be brought in complete contact, and fastened together. The object of this is to make the surface appear as if the material had been of the finest and most rich quality; for this reason the ground may be of inferior wood, and the veneer of the most superior kind.

W.

WARPING of WOOD, is the position which a piece acquires in expelling the natural sap, and this is owing to an unequal contraction of the fibres. It is therefore improper to construct articles of furniture of unseasoned wood, since the surfaces will not only be liable to shake and split, but also to twist, and consequently to take a very different postiion to that intended.

WASH-HAND BASON STAND, a stand for holding a bason for washing. These stands are of various forms.

WASH-HAND TABLE, a table with conveniencies for washing.

WAX POLISHING, is a method of polishing by rubbing the surface with hard bees-wax, and completing the operation of polishing by rubbing with corks, brushes, and linen rubbers. This kind of polish is used in various stained articles, as also for chairs and bedsteads.

WINDOW CORNICES, the cornice to which the curtains of a window are hung.

WINGED WARDROBE, a wardrobe with wings.

LONDON: H. FISHER, PRINTER TO HIS MAJESTY.

Basin Stands and Pot-de-Chambre Recess.

Fig. 1. *Fig. 2.*

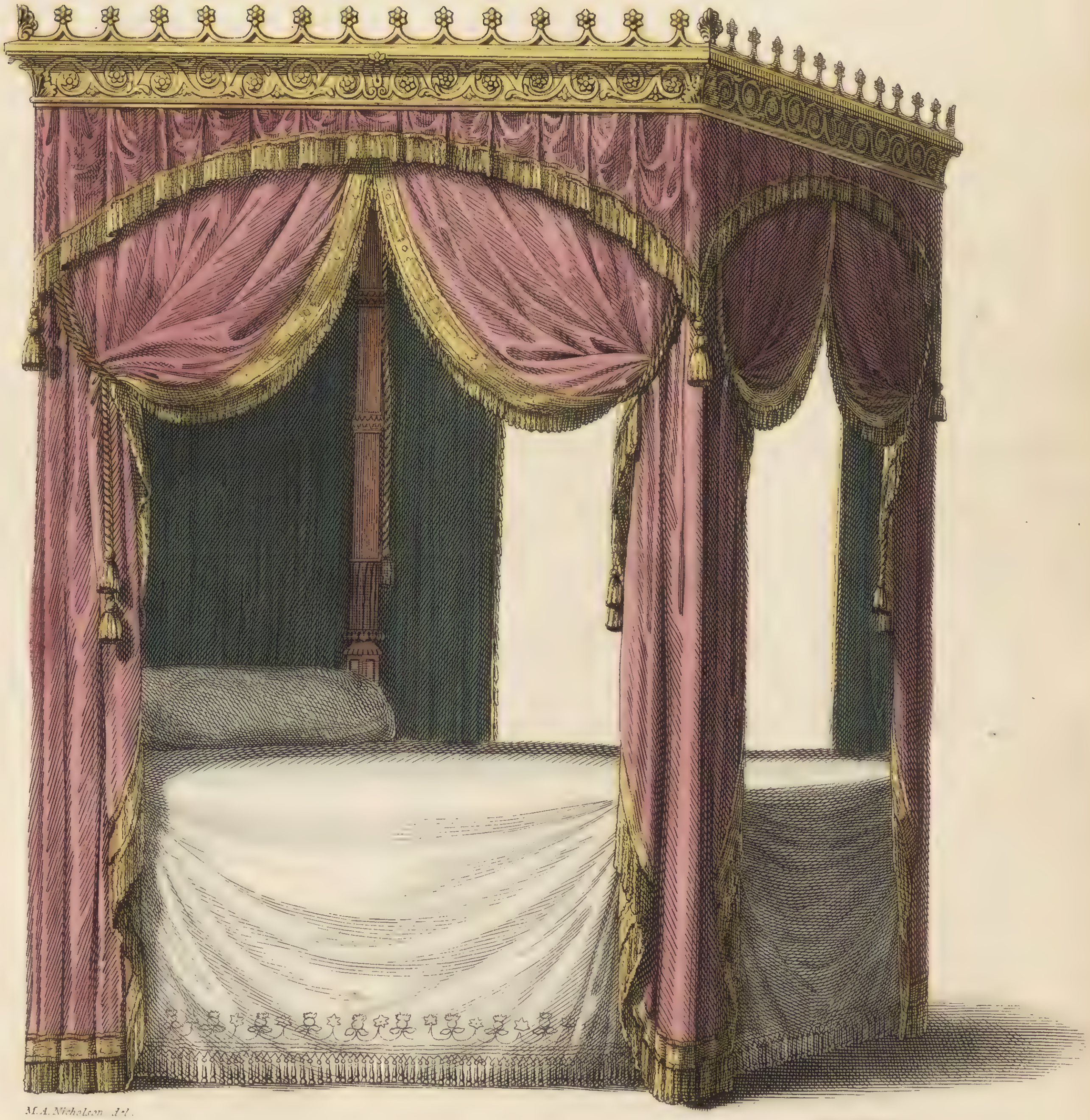
A B

M.A. Nicholson del. W. Symes sculp.

[illegible] 1835.

Bed in the Grecian Style.

Four Post Bed.



M.A. Nicholson del.

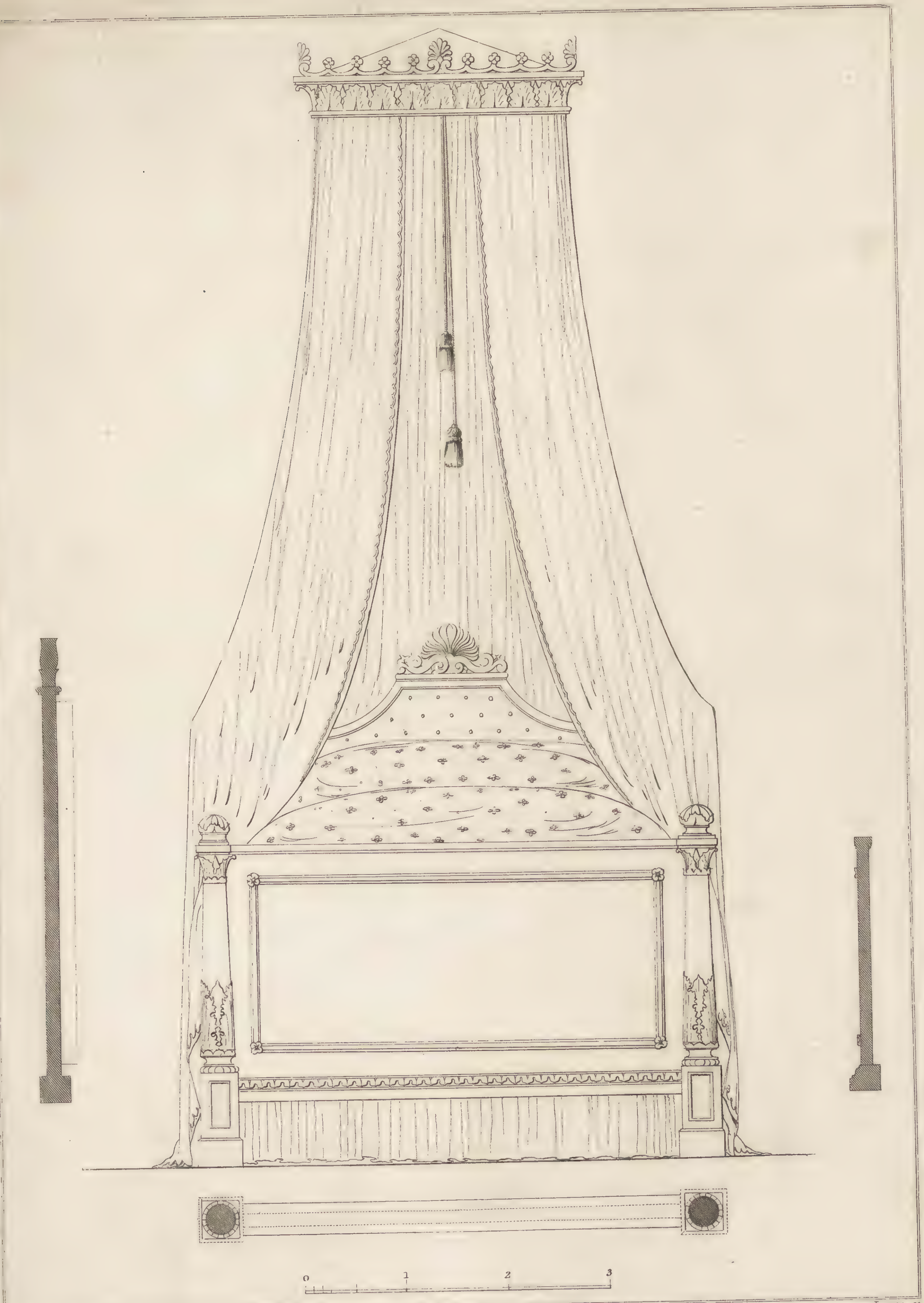
Cosmo Armstrong sc.

Published by Fisher Son & Co. Caxton, London 1826.

Gothic Bed.

Published by H. Fisher Son & Co. Caxton, London, Aug. [illegible] 18[illegible]

A French Bed.

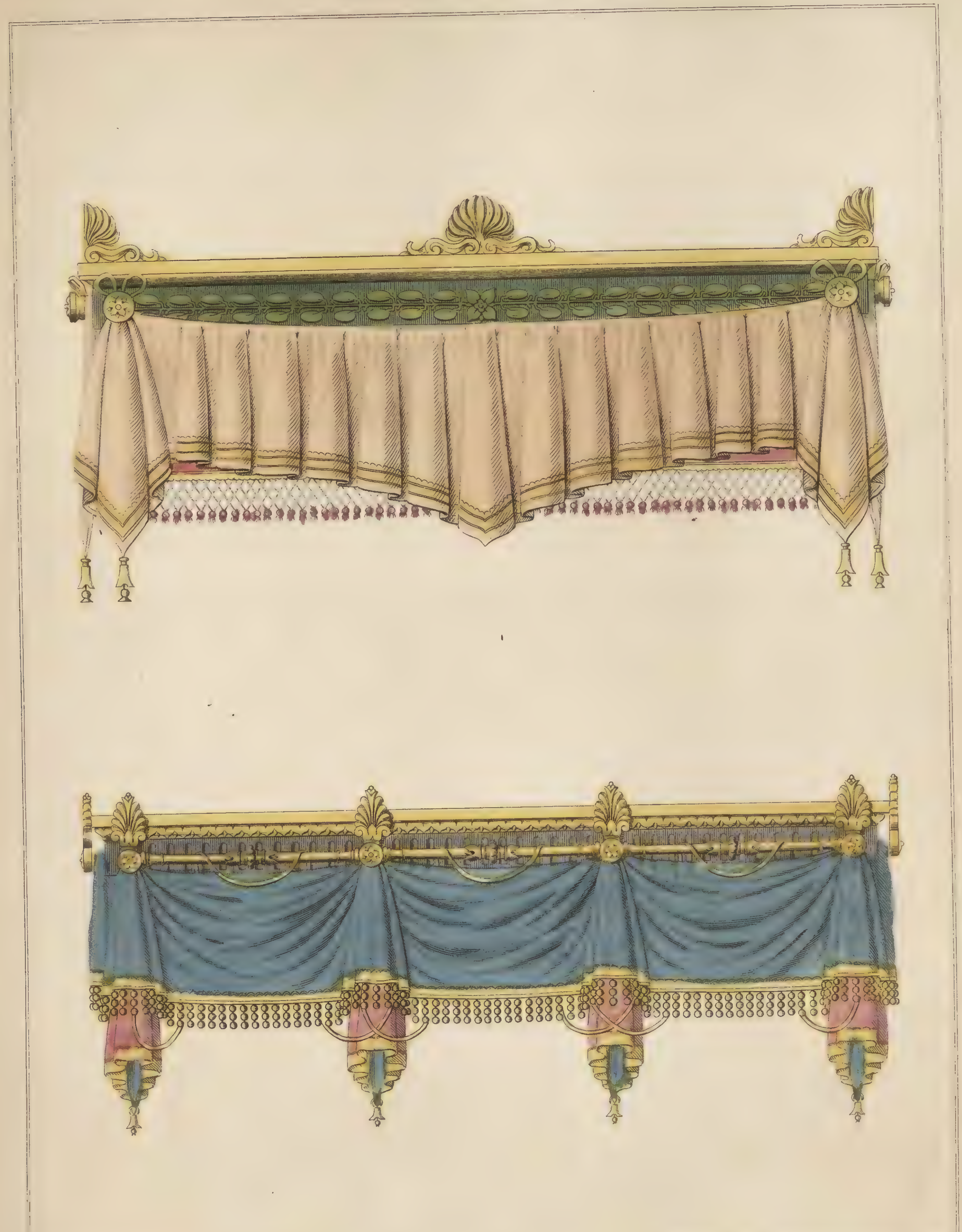


Designed by M.A. Nicholson.

Lowry, sc.

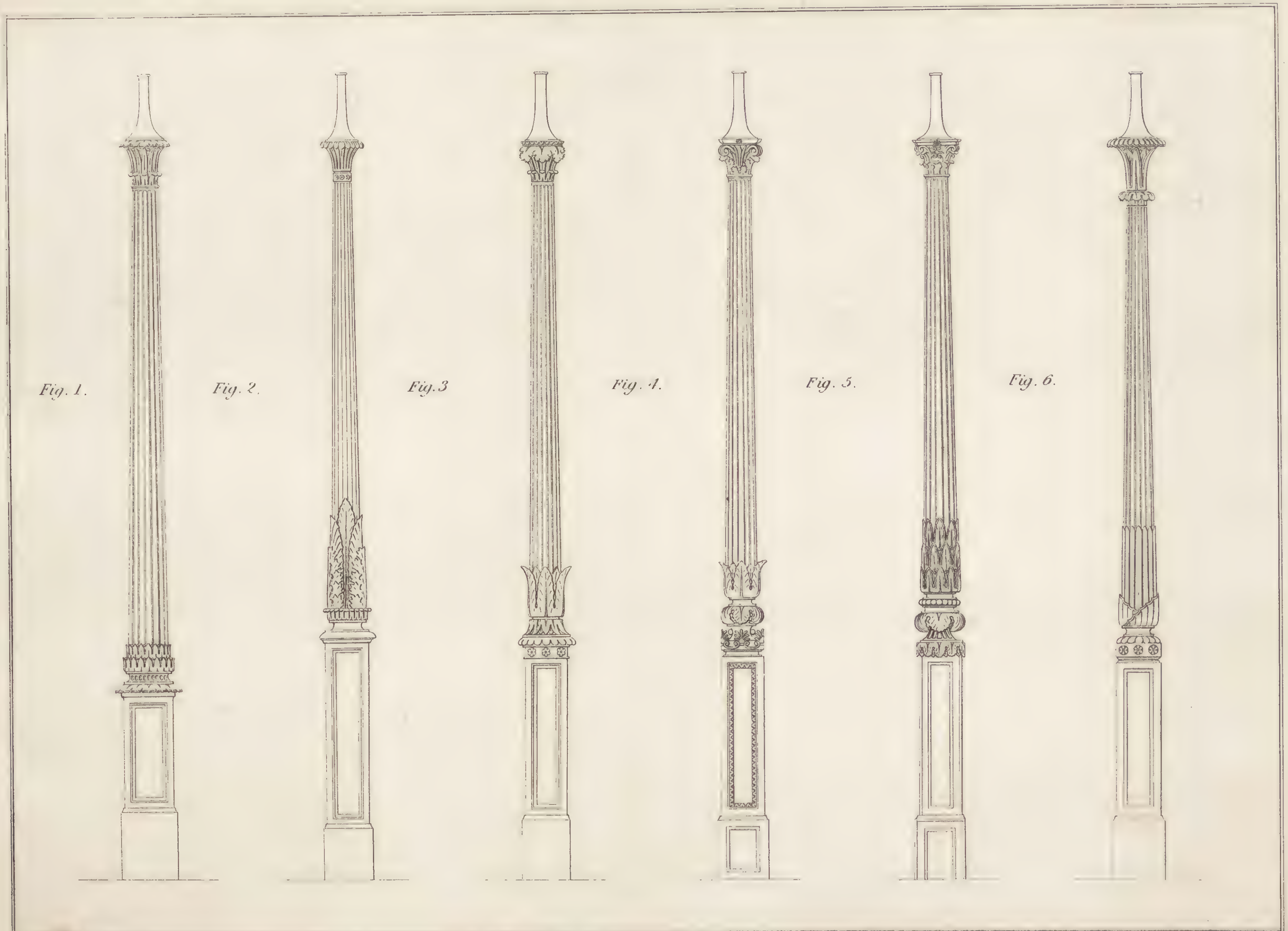
Published by Fisher, Son & Co. Caxton, London, May, 1834.

Bed Cornices & Drapery.



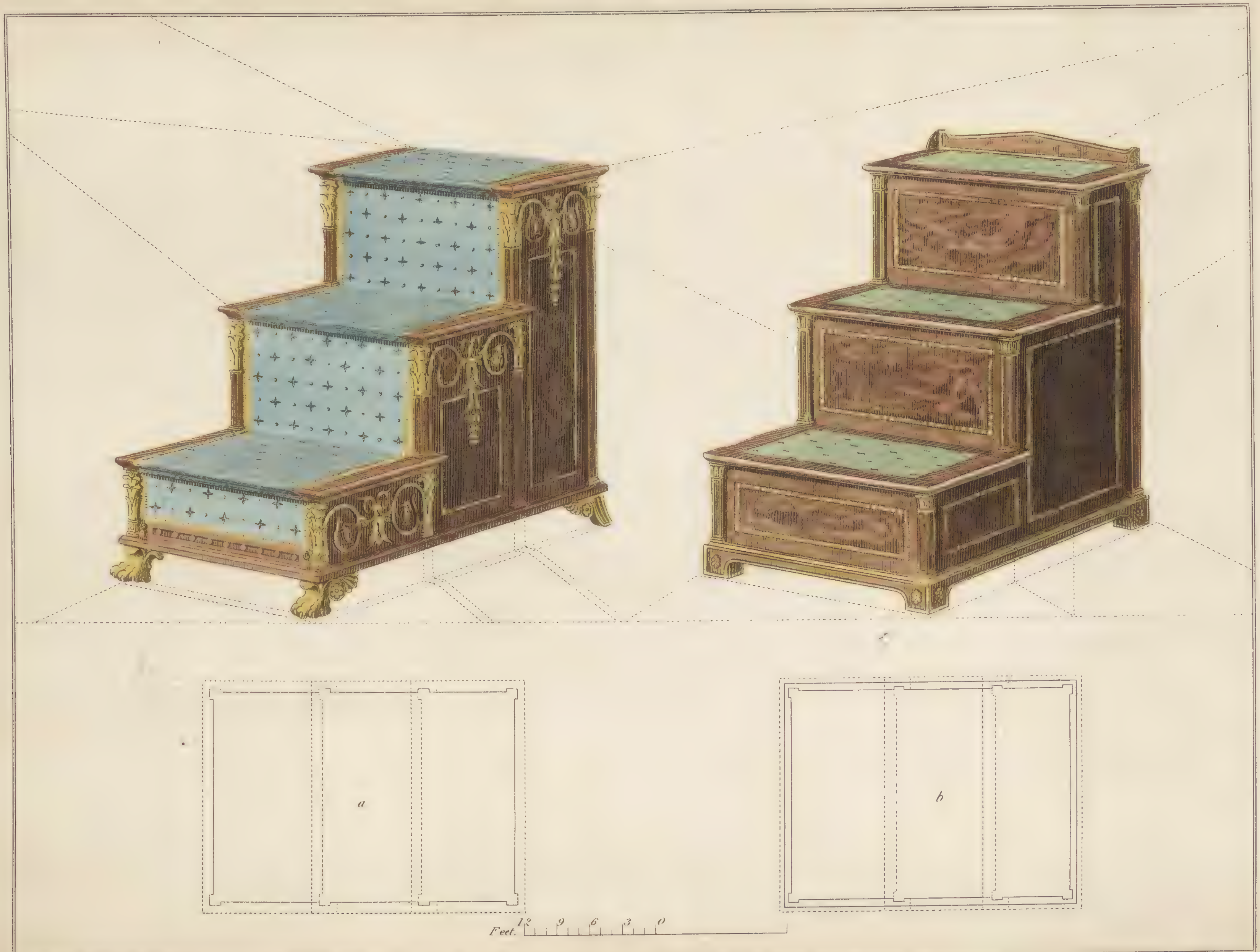
Published by H. Fisher Son & Co. London Sept 1834

Bed Posts.



Published by [illegible] 1835.

Bed Steps.

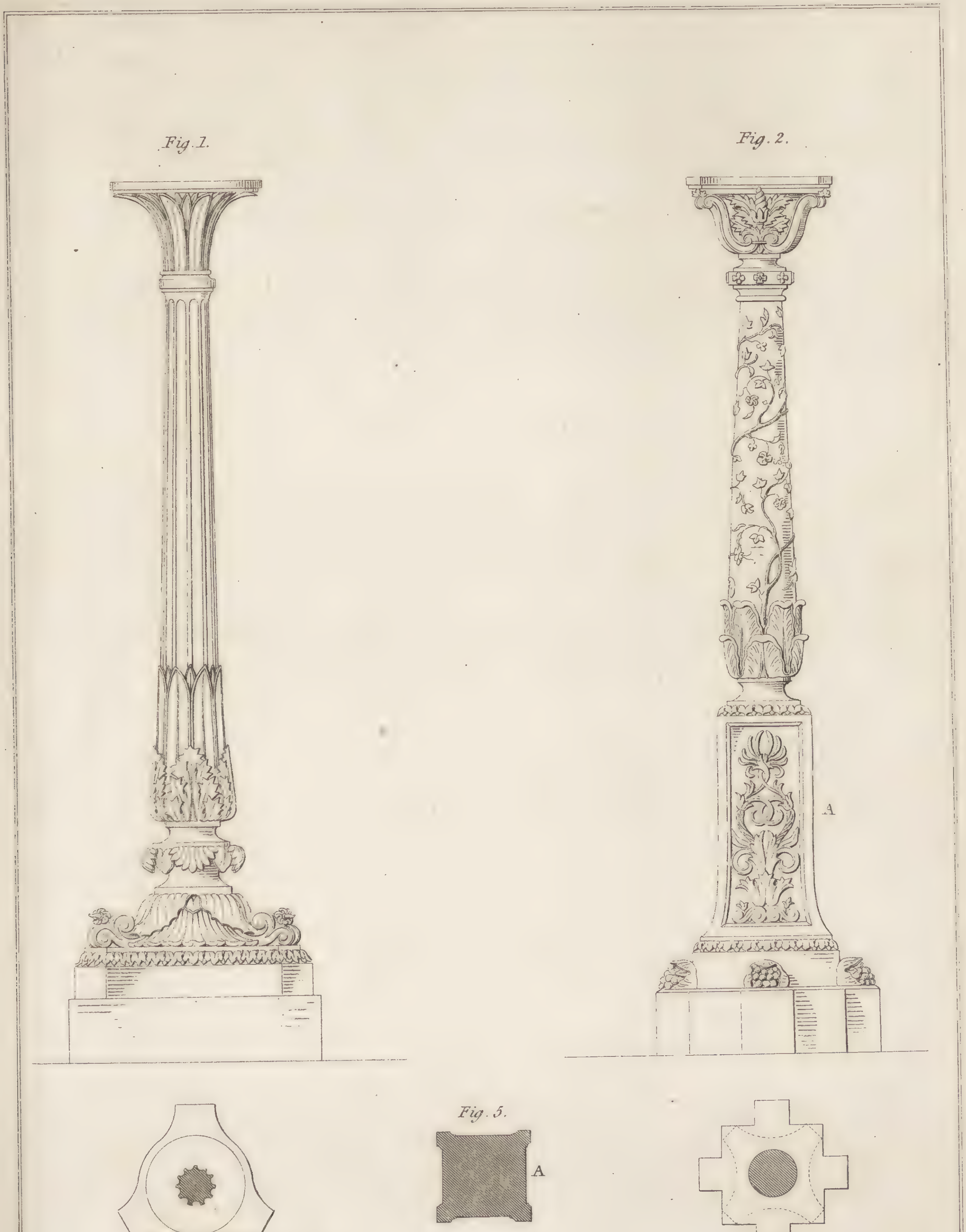


FISHER SON & Co LONDON. 1833.

Bookcase.

Published by Fisher, Son & Co. Caxton, London, April 1835

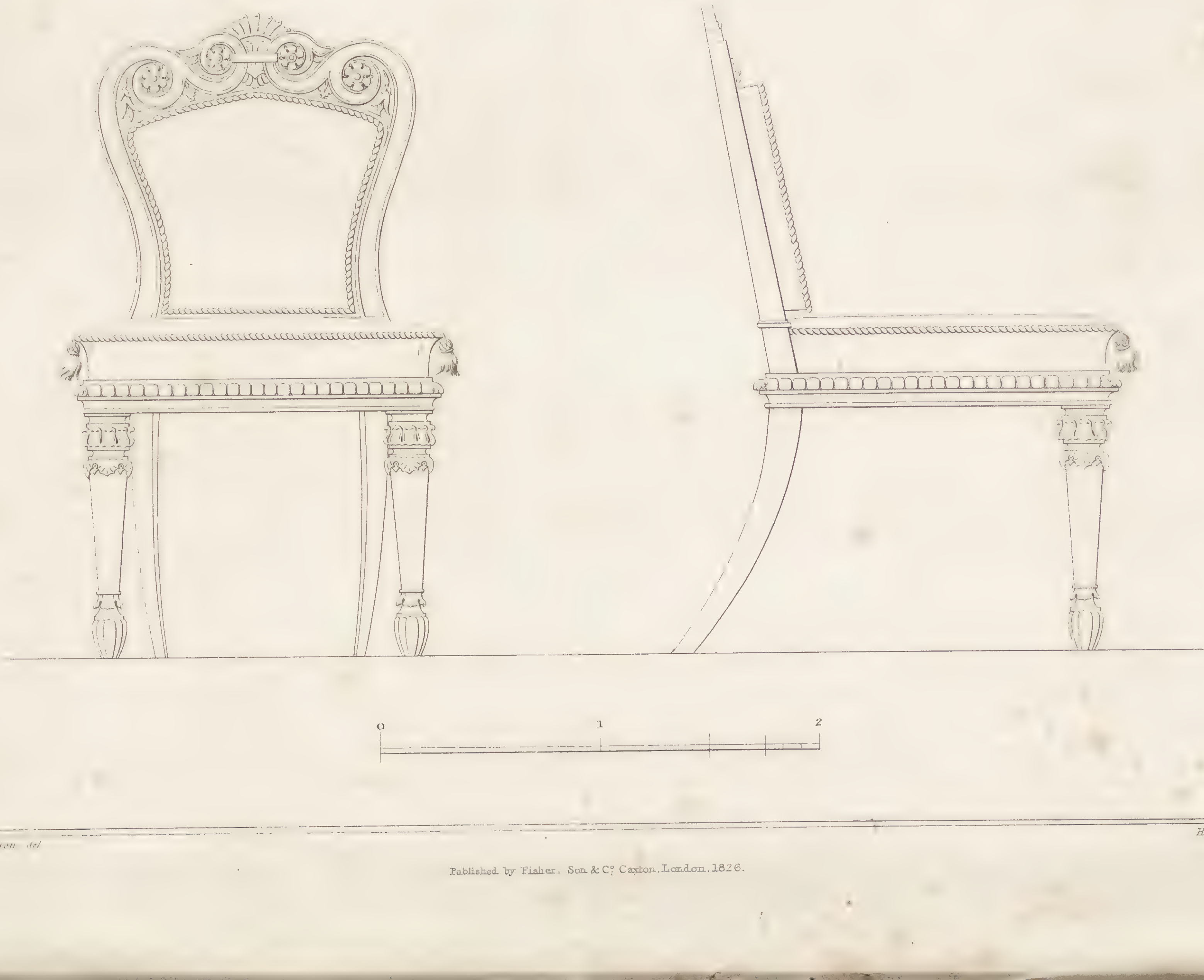
Candelabri.



Designed by M.A. Nicholson. Lowry sc.

Published by Fisher, Son & Co. Caxton, London, May 1835.

Drawing Room Chairs.



M. A. Nicholson del.

H. Summons sc.

Published by Fisher, Son & C.º Caxton, London, 1826.

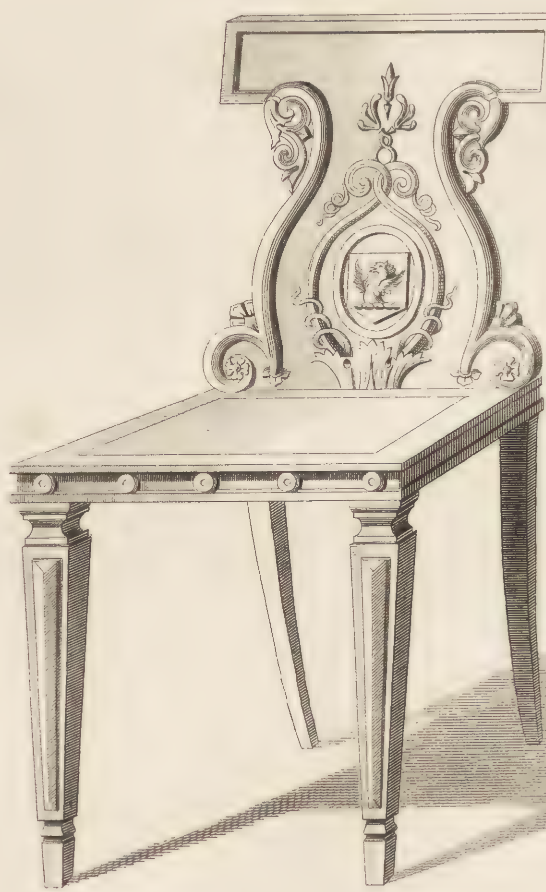
Drawing Room Chairs.

Designed & Drawn by M. A. Nicholson

Simmons sculp.

Published by Fisher, Son & Co. Caxton London Nov. 1st 1826.

A Hall Chair.



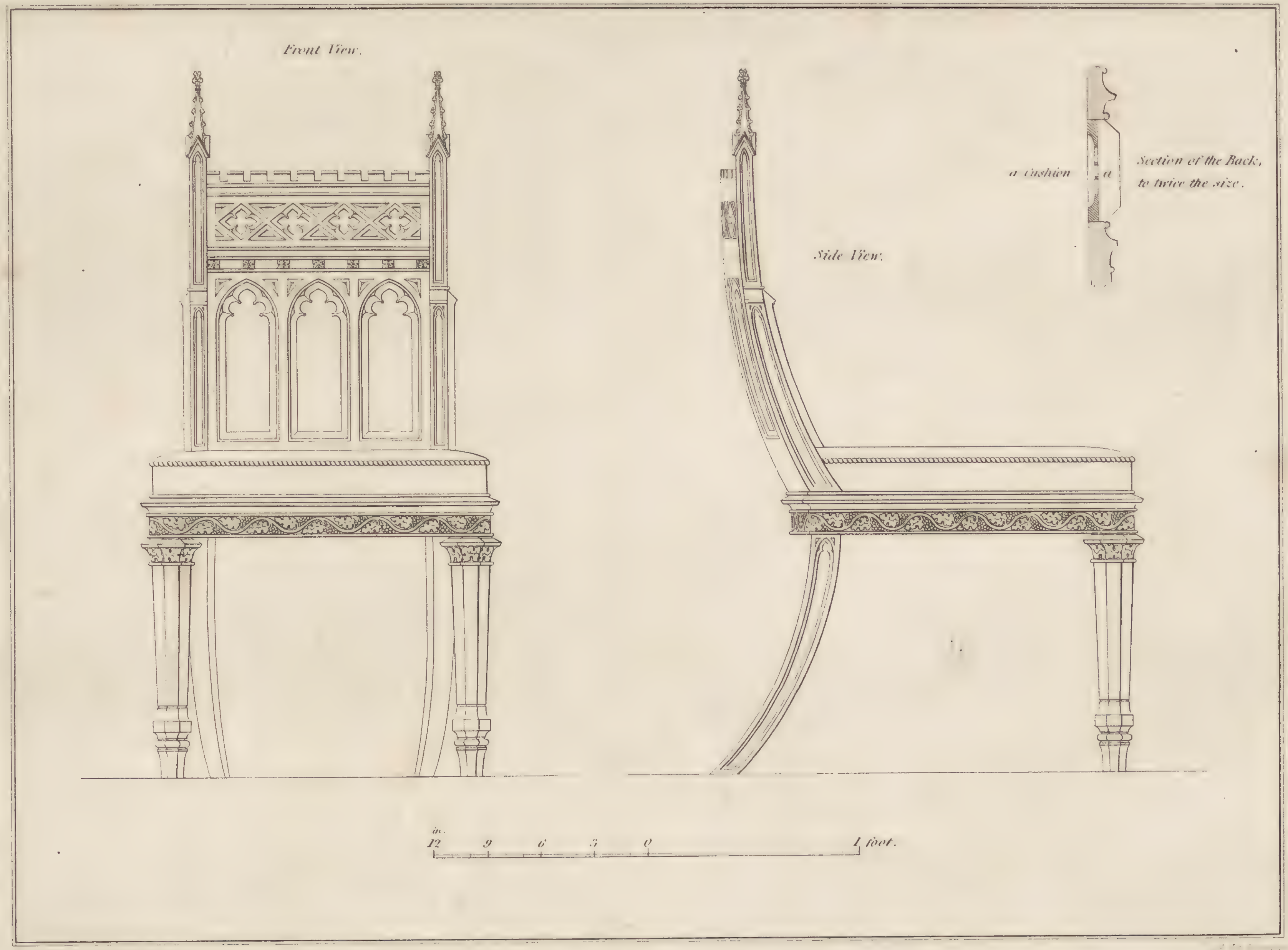
A Drawing Room Chair.

M. A. Nicholson del.

FISHER, SON & C° LONDON 1833

Gothic Chair:

To correspond with Gothic Side Board.



signed & Drawn by M.A Nicholson.

Published by [illegible] & Co [illegible] 183[illegible]

Arm Chair.

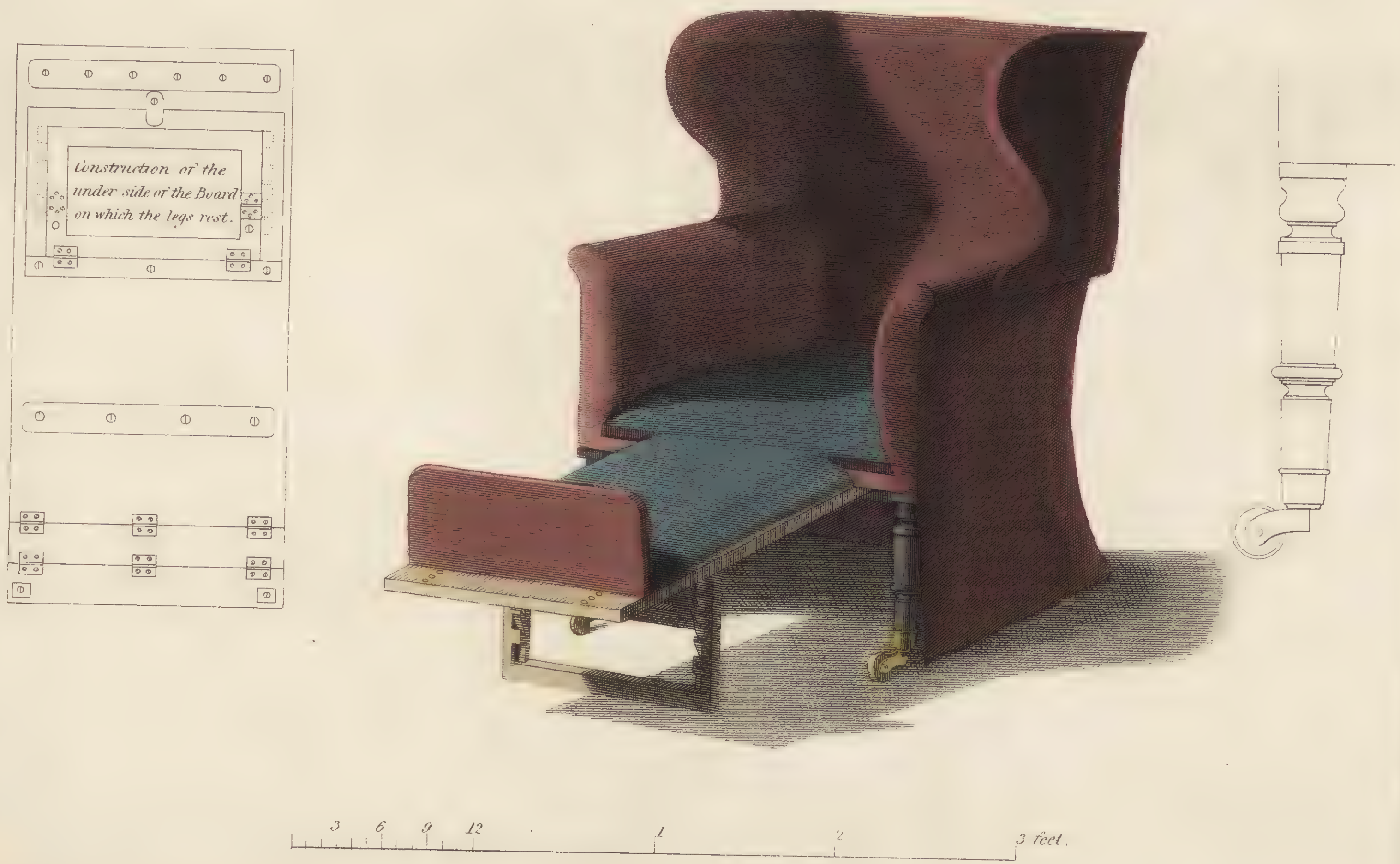
M.A. Nicholson del.

Allen. sc.

Published by Fisher, Son & Co. Caxton, London, June 1, 1826.

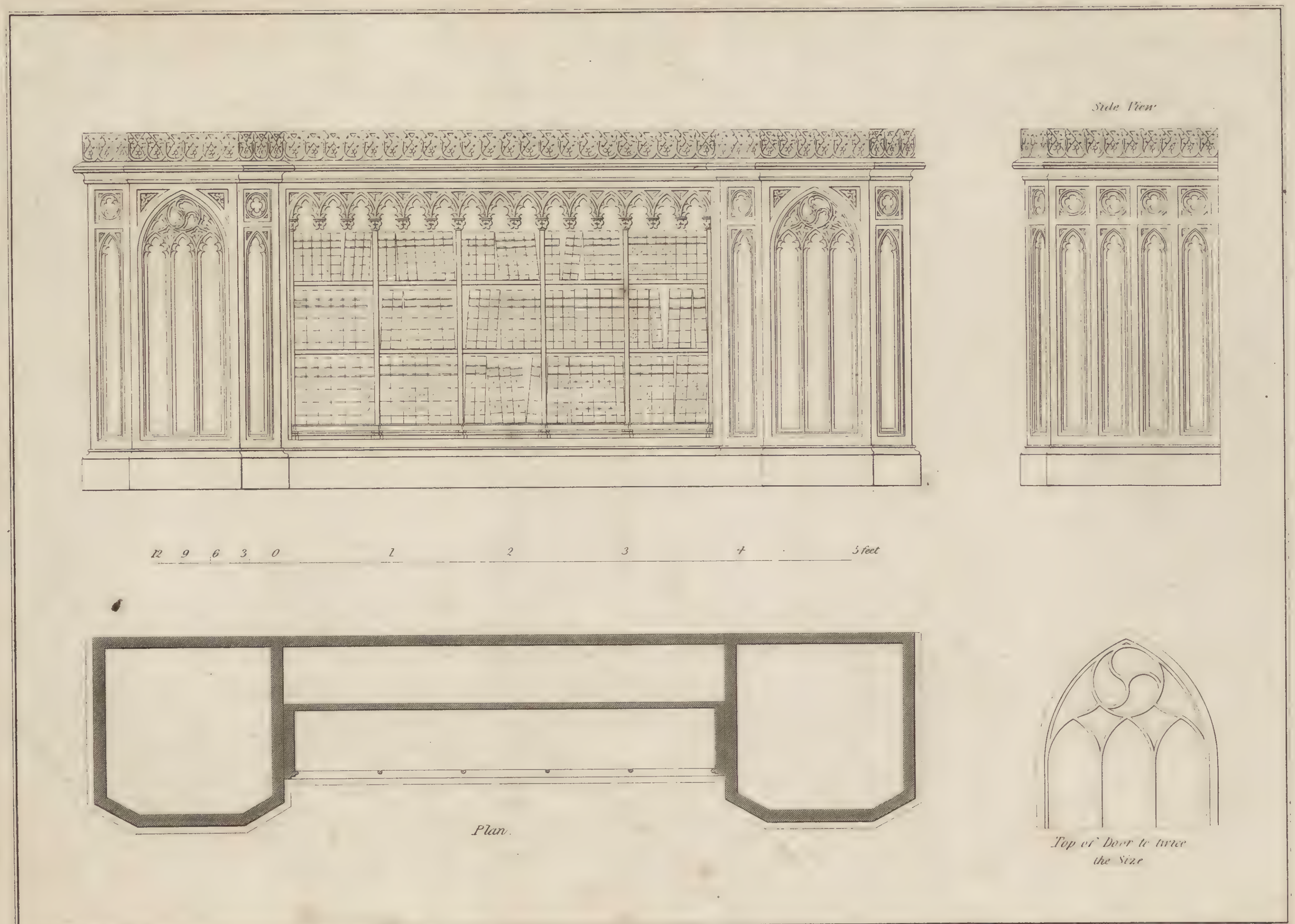
The Chair in which the late Duke of York died.

(Executed by Mr. E. Bailey, Upholsterer to the King.)



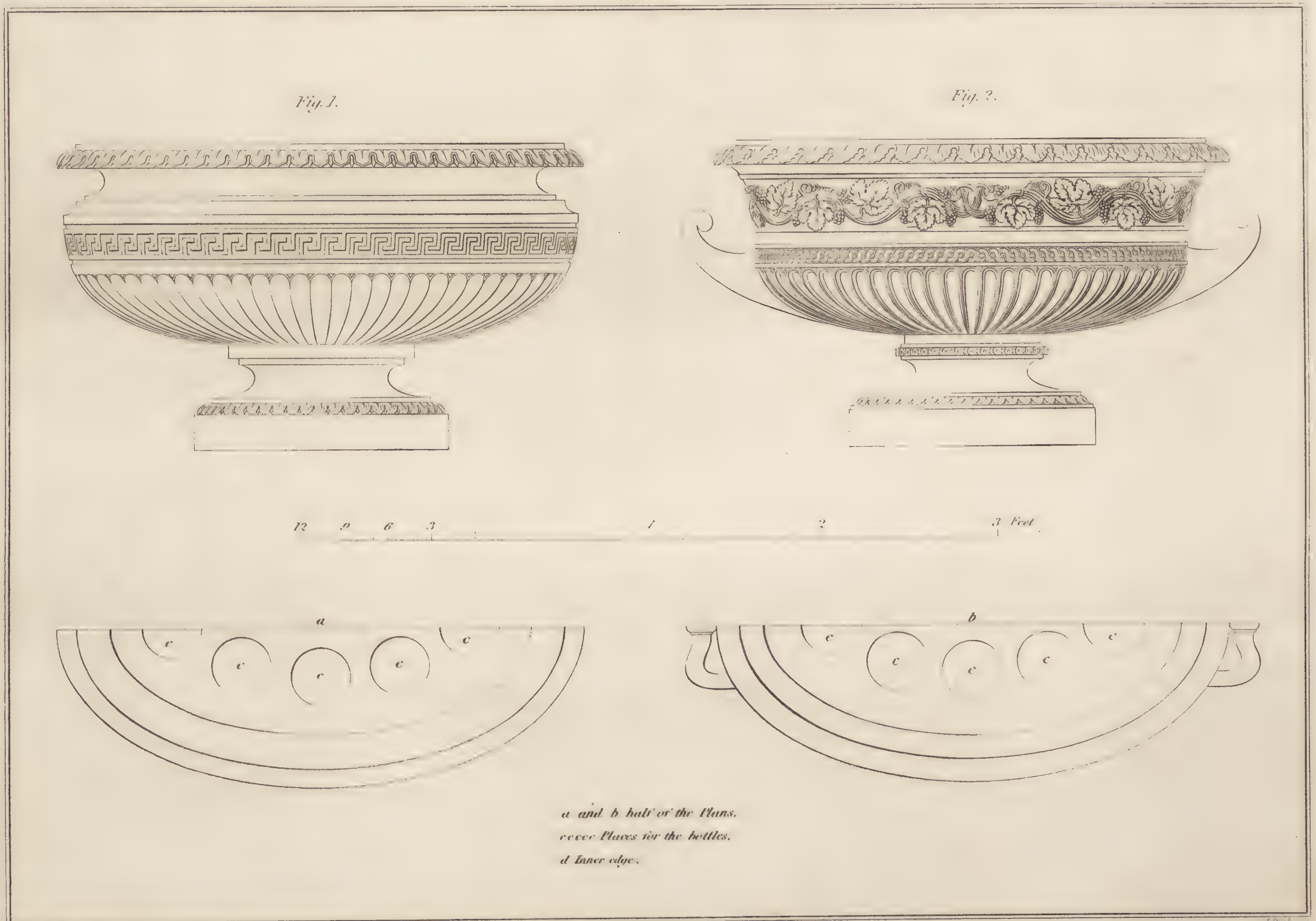
Published by Fisher, Son & Co. London 1835.

Drawing Room Gothic Commode.



Designed & Drawn by M.A. Nicholson

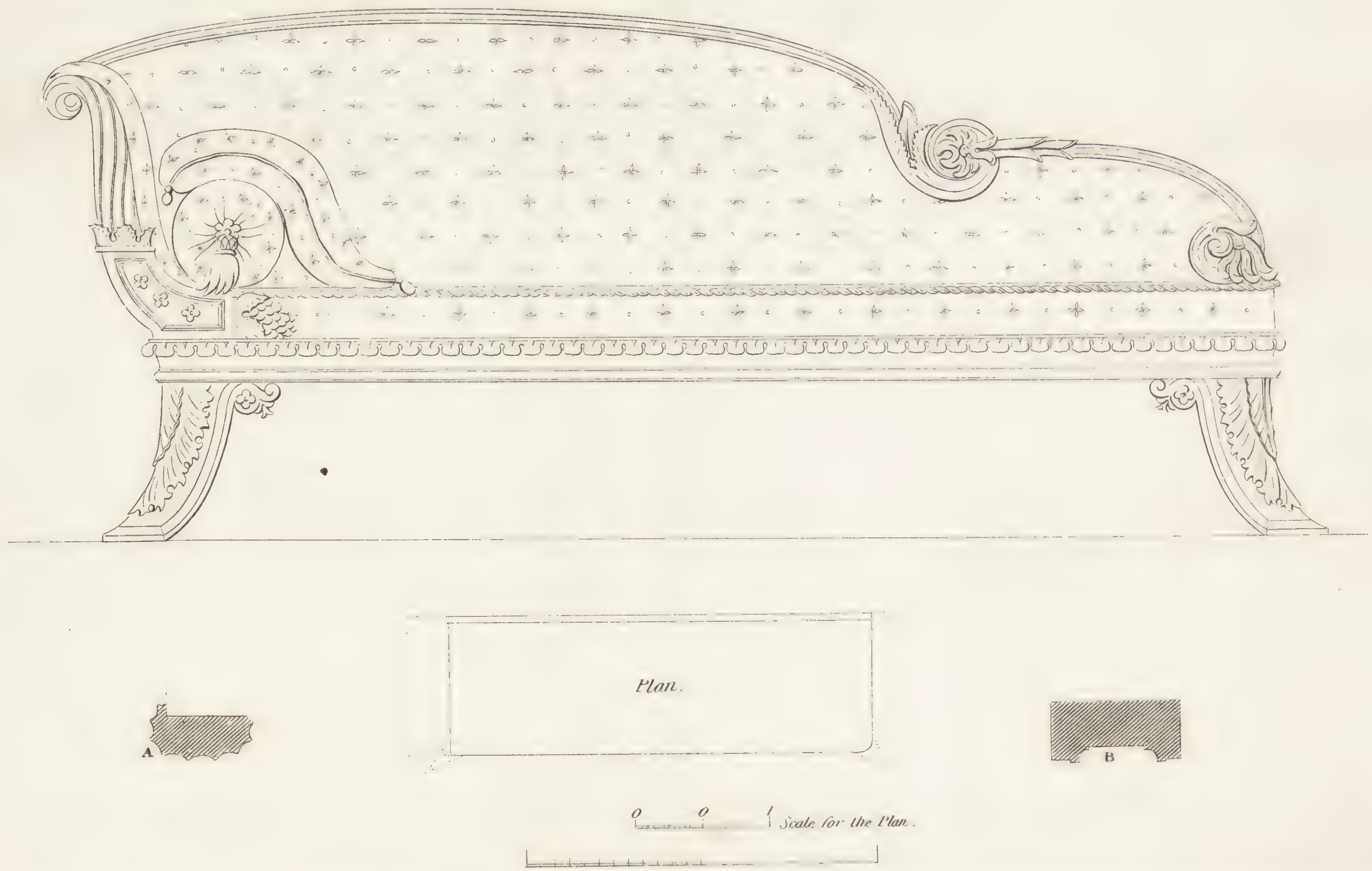
Wine Coolers.



J. Dick, sc

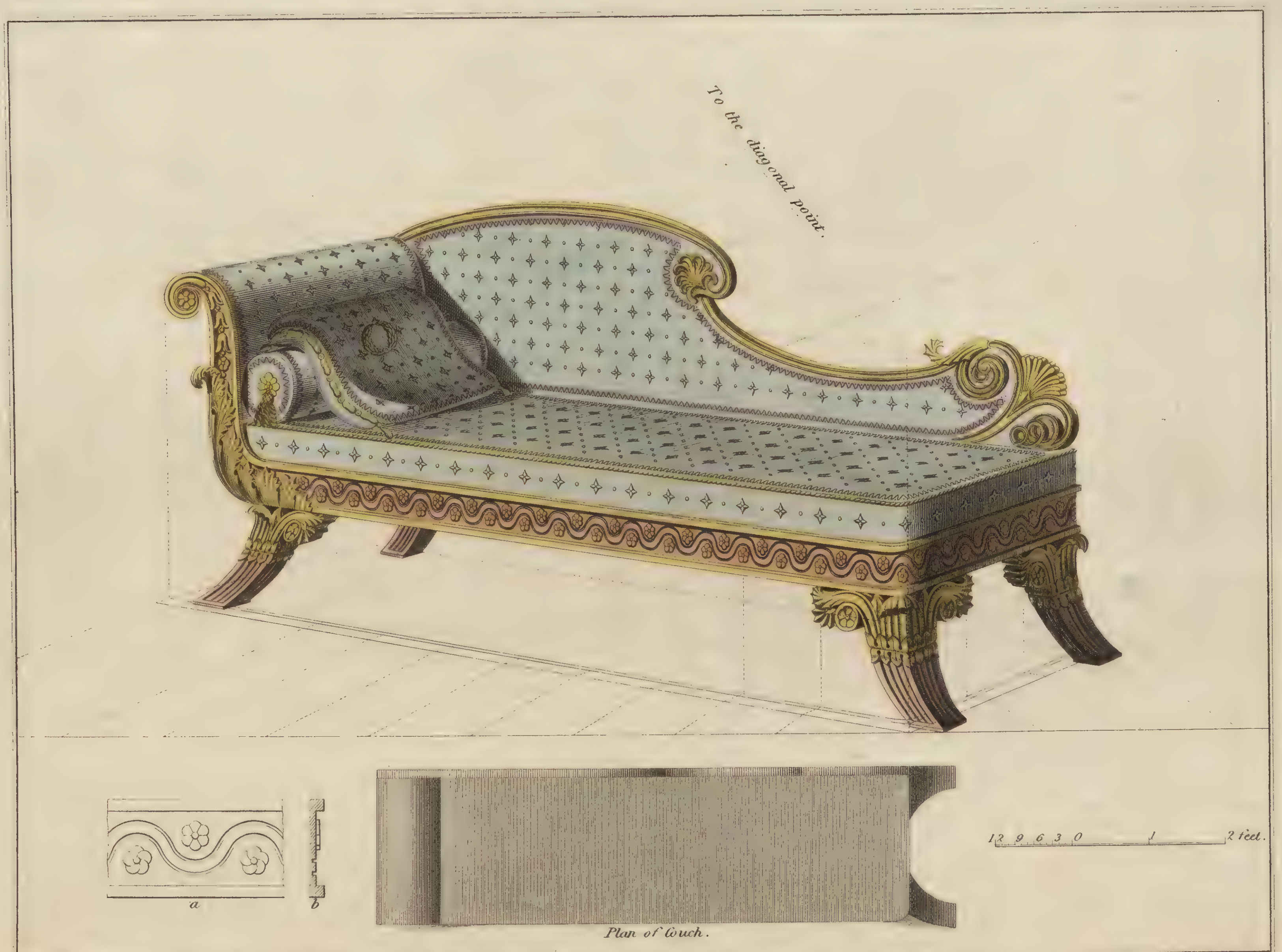
Published by Fisher, Son & Co. Caxton, London, 1835.

A Couch.



Published by Fisher, Son & C° Caxton London Dec.r 30 1834.

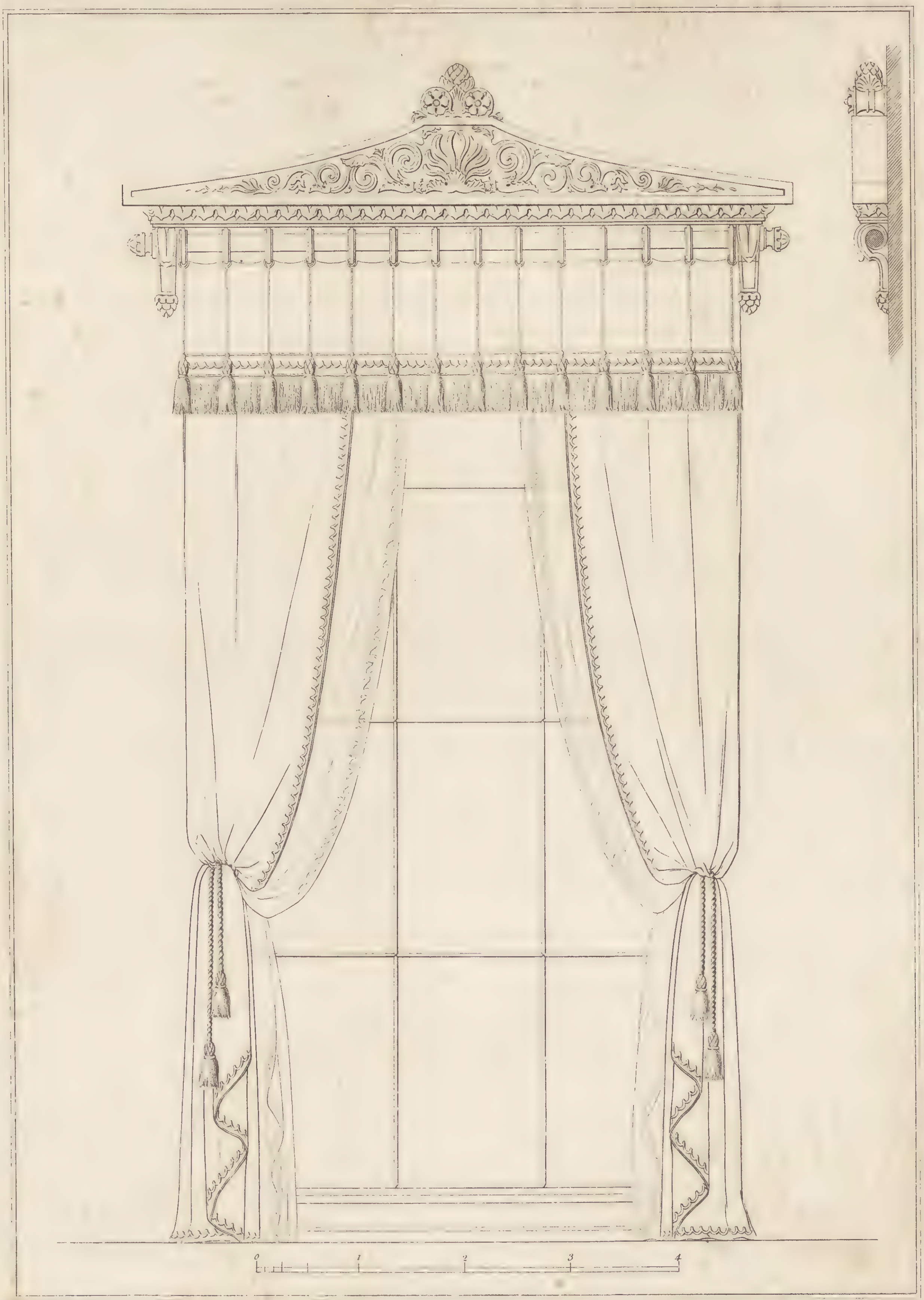
A Couch in the Grecian Style.



Designed by M. A. Nicholson

Published by H. Fisher, Son & Co. Caxton, London, Nov. 11, 1826.

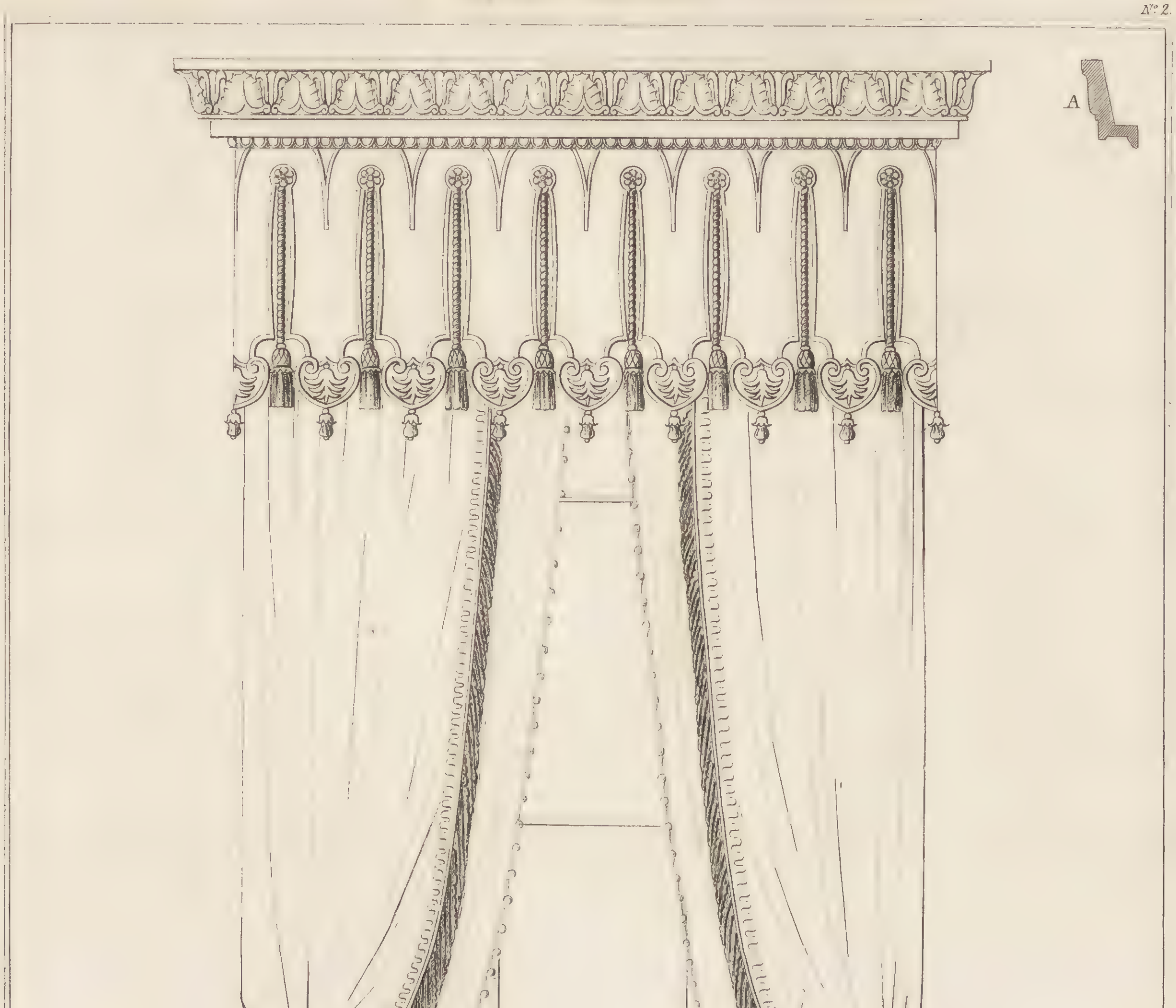
Window Curtain.



[illegible] del. [illegible] sc.

[illegible] Son & Cº Caxton [illegible]

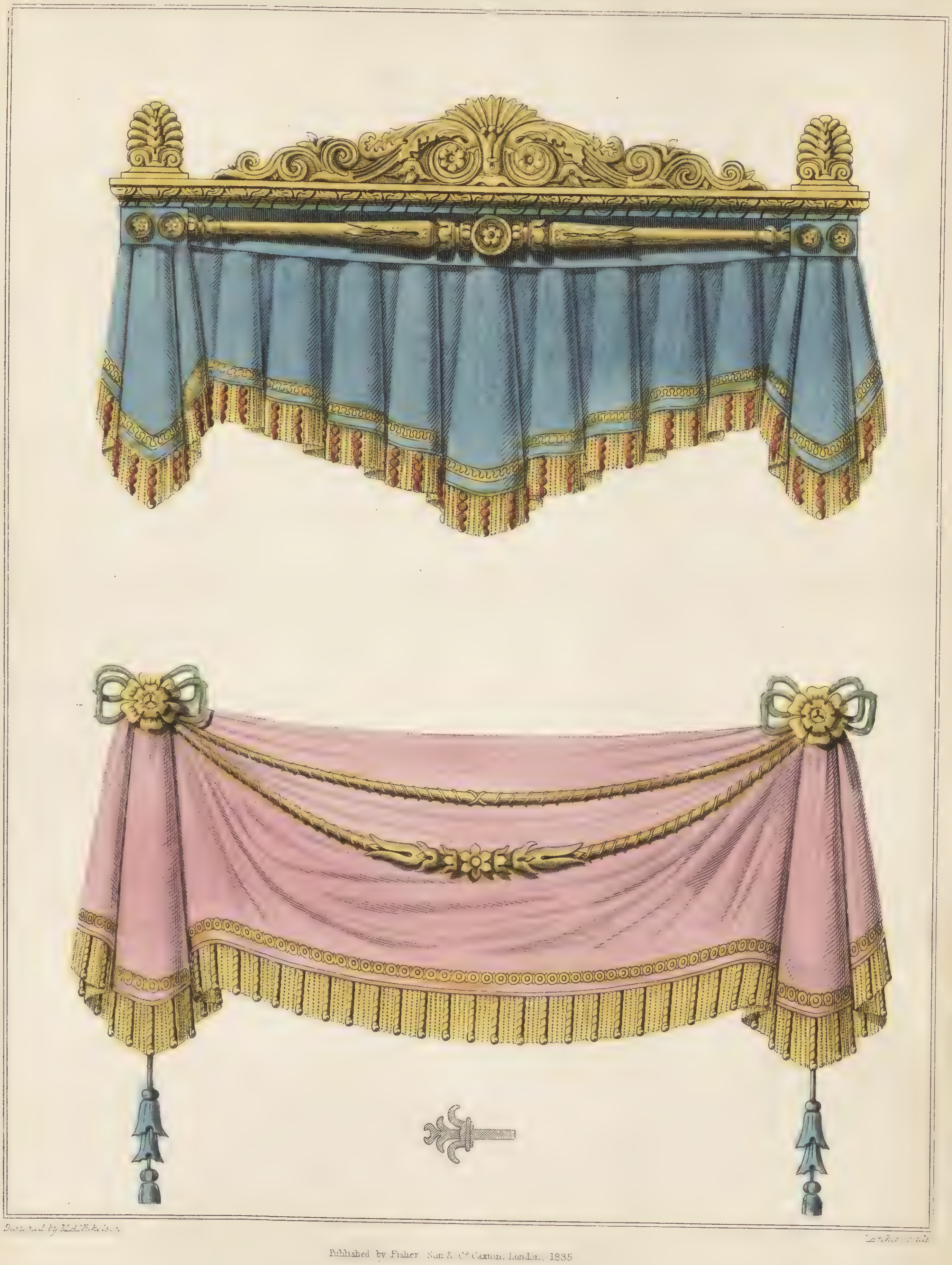
Window Curtain.



M. A. Nicholson del. *J. Henshall sc.*

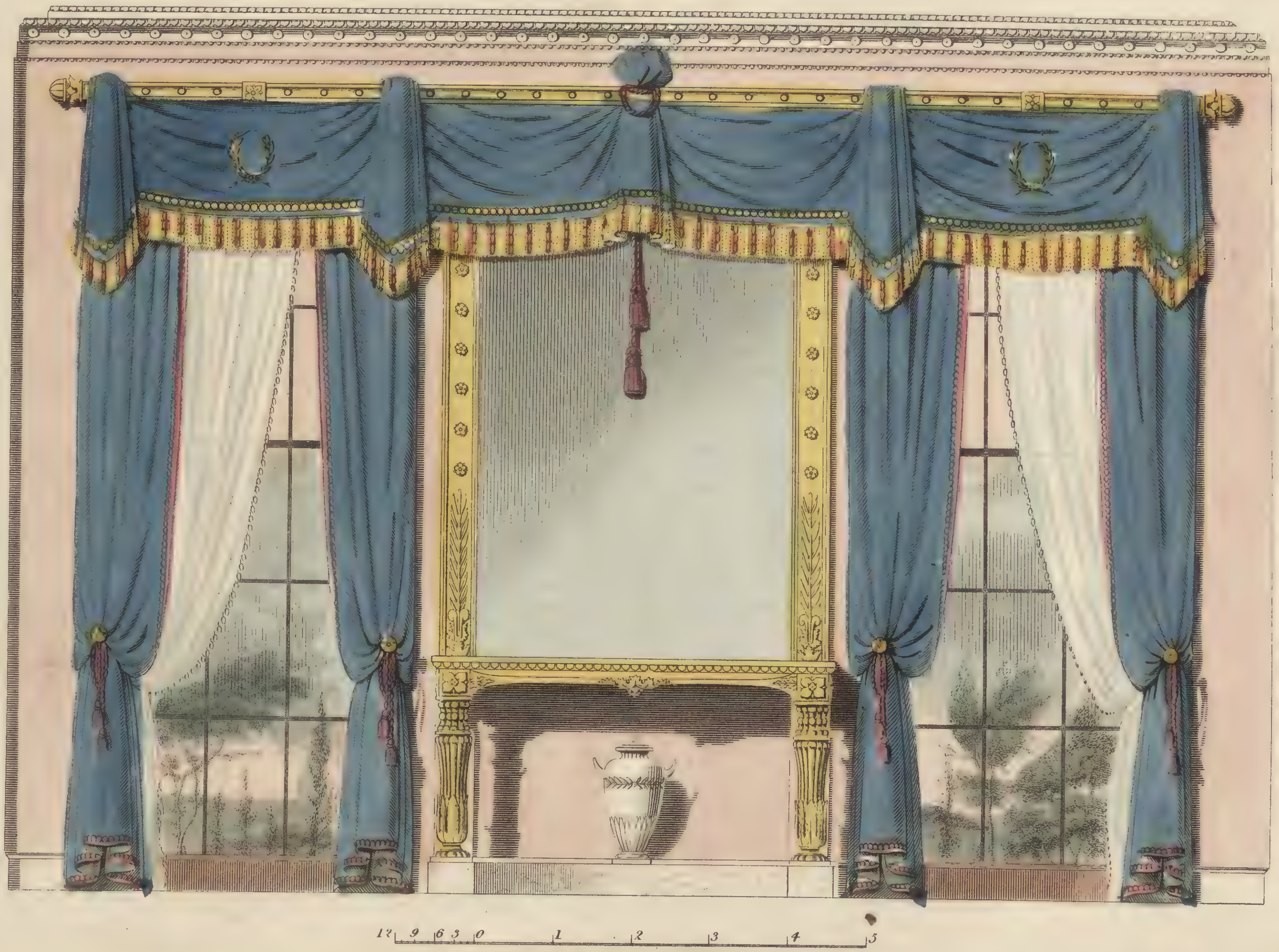
Published by Fisher Son & Co. Caxton London May 1834

Window Curtains.



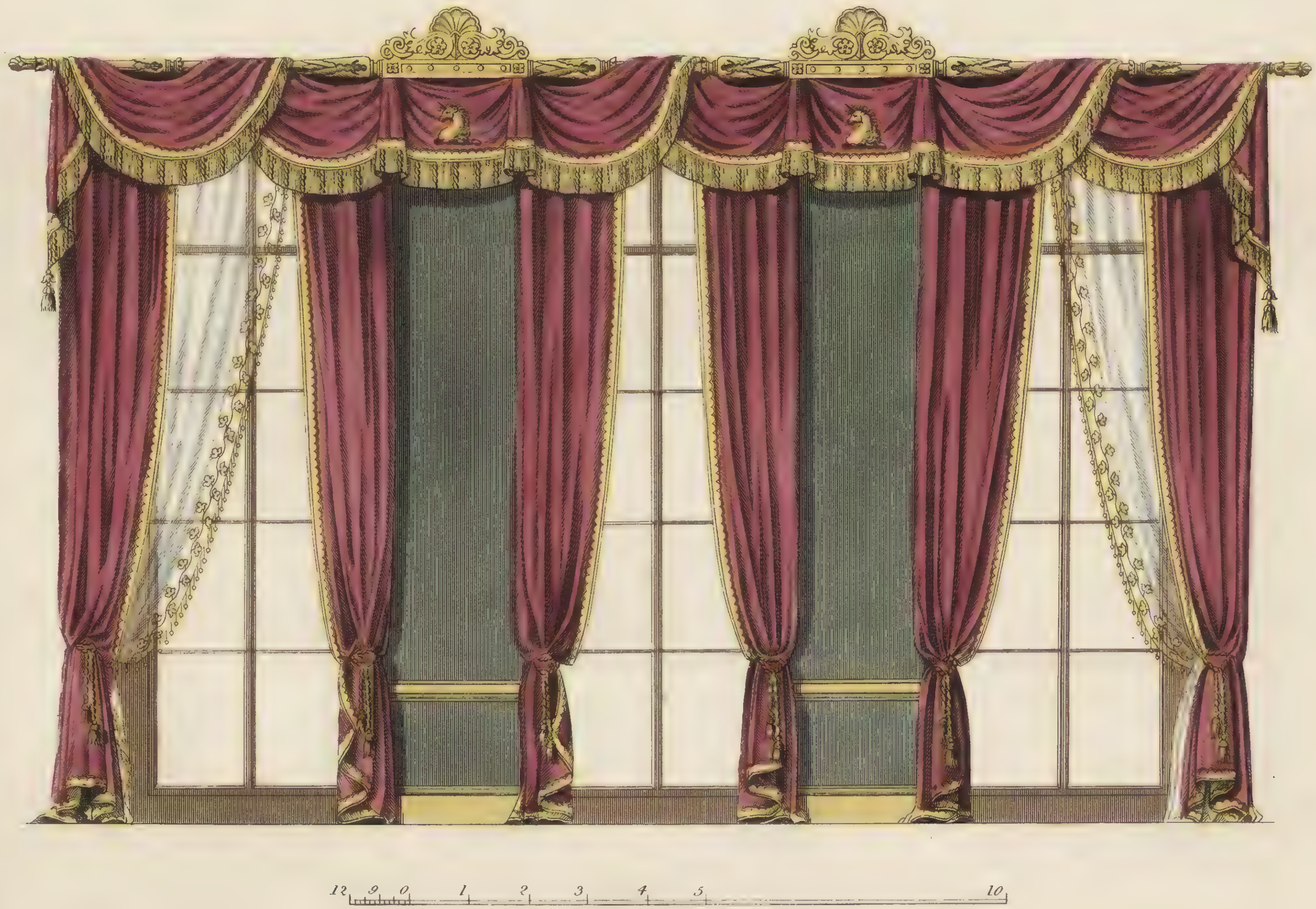
Published by Fisher Son & C° Caxton, London, 1835

Curtains for two Windows.



Published by [illegible]

Drapery for three Windows.



M. A. Nicholson del.

London 1834

Greek Pateras.

Fig. 1.

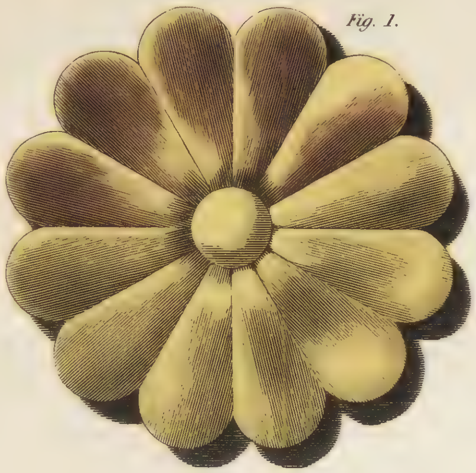


Fig. 2.

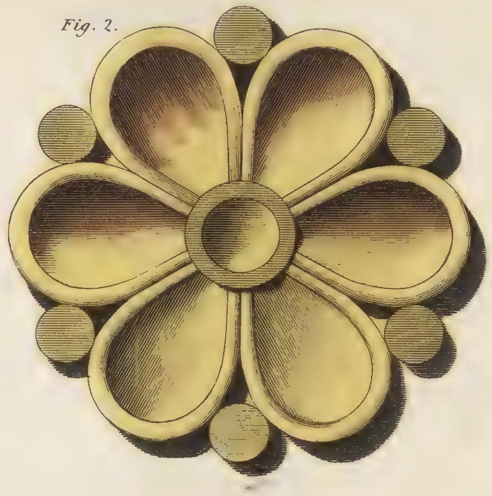


Fig. 3.

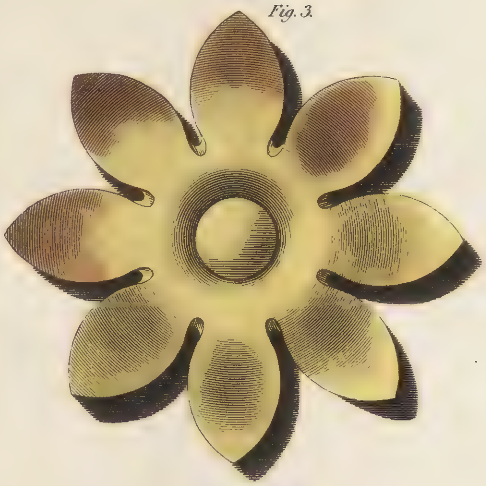


Fig. 4.

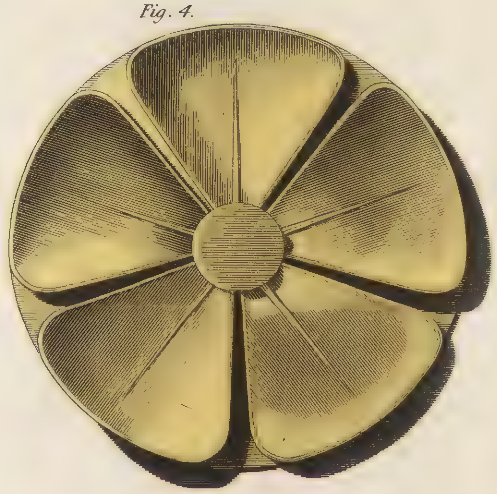


Fig. 5.

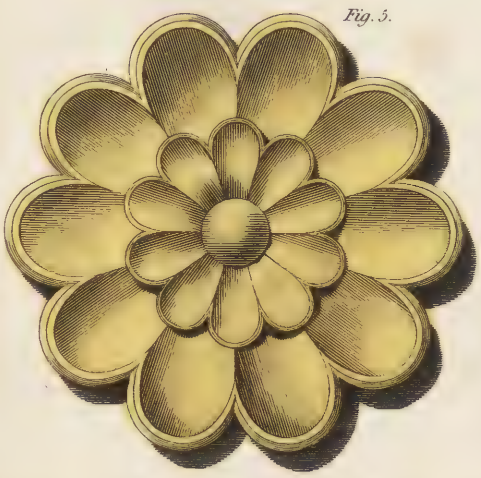
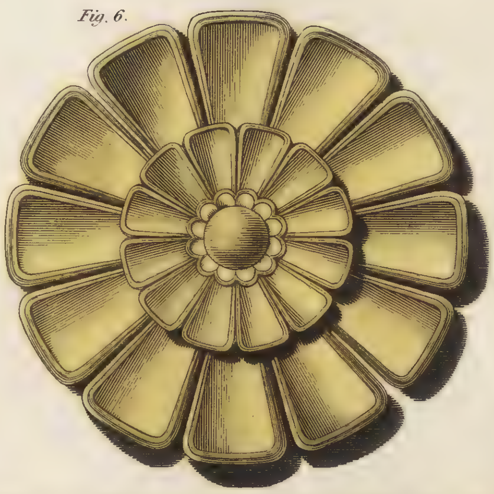


Fig. 6.



Drawn by M.A. Nicholson. *J. Archer sc.*

Published by Fisher, Son & C°. Caxton, London. 1834.

Elements of Foliage.

M. A. Nicholson del.

FISHER, SON, & Co. LONDON.

Elements of Foliage.

M. A. Nicholson del.

Kelsall sc.

Published by Fisher Son & Co. Caxton London June 1. 1826.

Elements of Foliage.

Fig. 1.

Fig. 4.

Fig. 3.

Fig. 2. N°. 1.

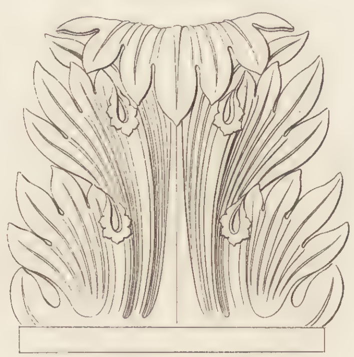


Fig. 2. N°. 2.

Fig. 5. Grecian Ornament.

M. A. Nicholson del.

Published by Fisher, Son & C°. Caxton London 1834

Grecian Ornaments.

Decoration Ornaments.

Fig. 2.

Fig. 1.

Fig. 4.

Fig. 3.

Published by [illegible] 1834.

Fig. 1.

Fig. 2.

M.A. Nicholson. del.

H. Summons. sc.

FISHER, SON & Co. LONDON. 1832.

Fig. 1.

Fig. 2.

Fig. 3.

M. A. Nicholson del.

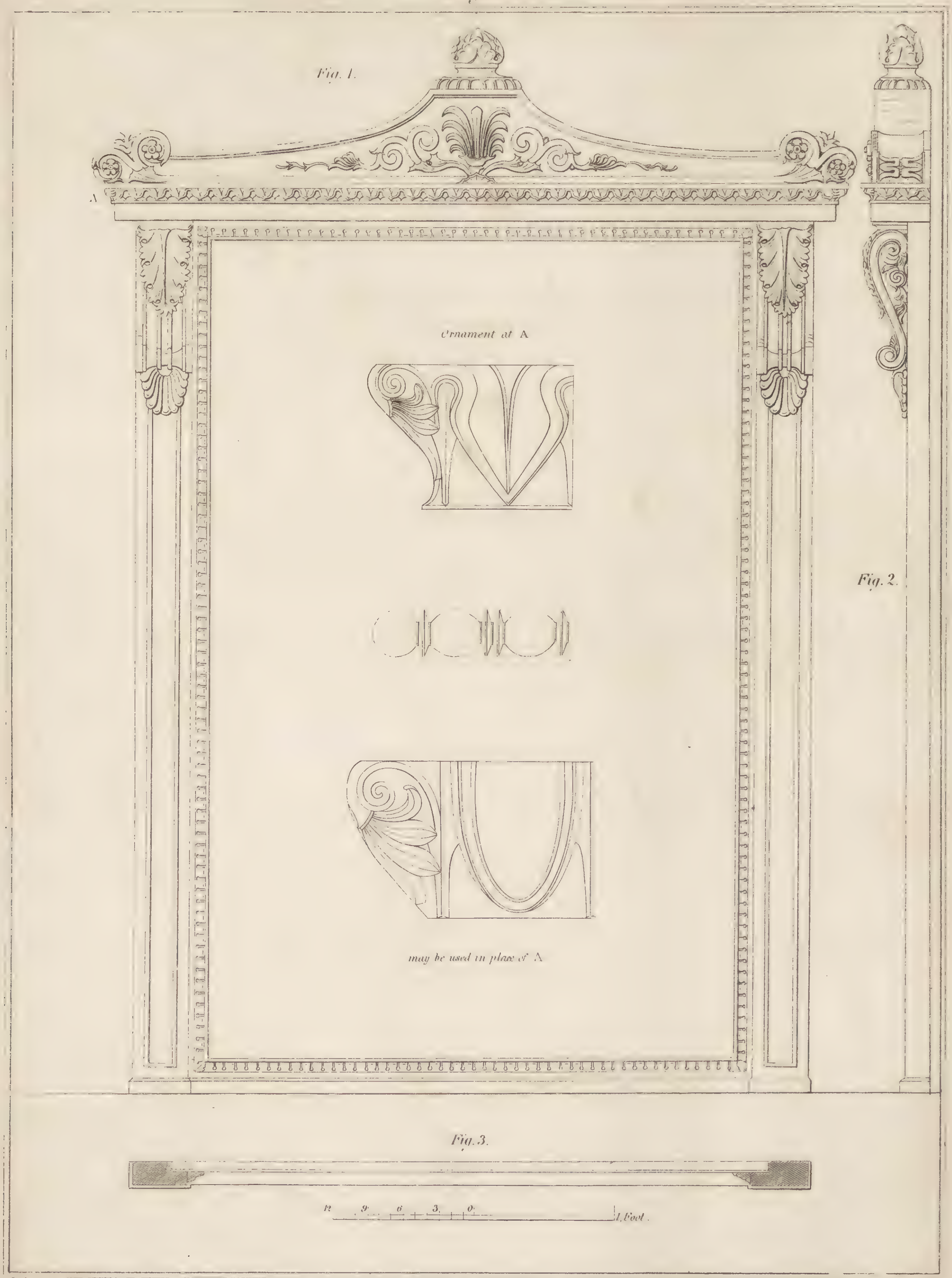
FISHER, SON & Co. LONDON. 1833.

Grecian Ornament.

M.A. Nicholson del.

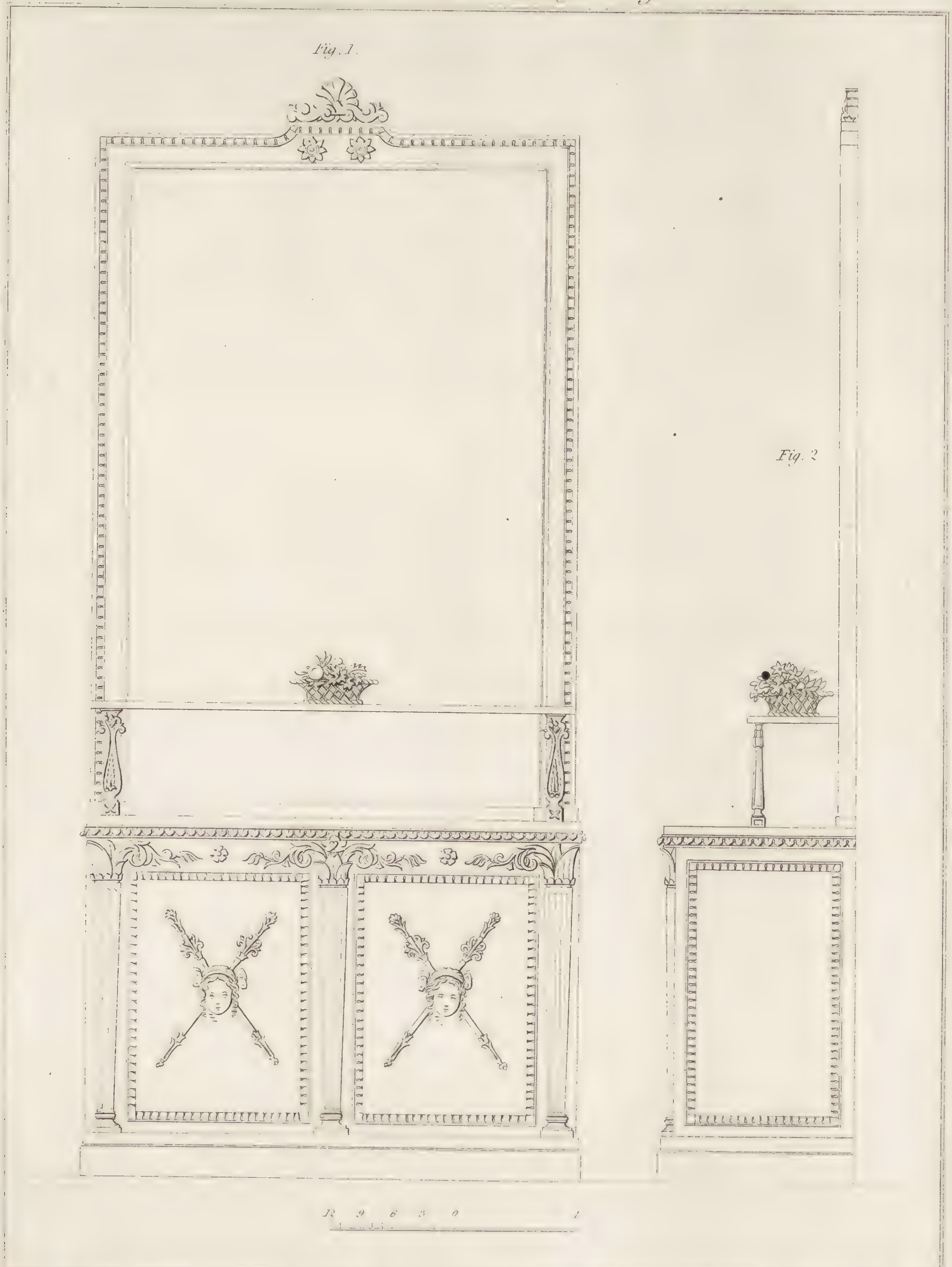
FISHER, SON, & Co. LONDON, 1835.

Looking Glass.



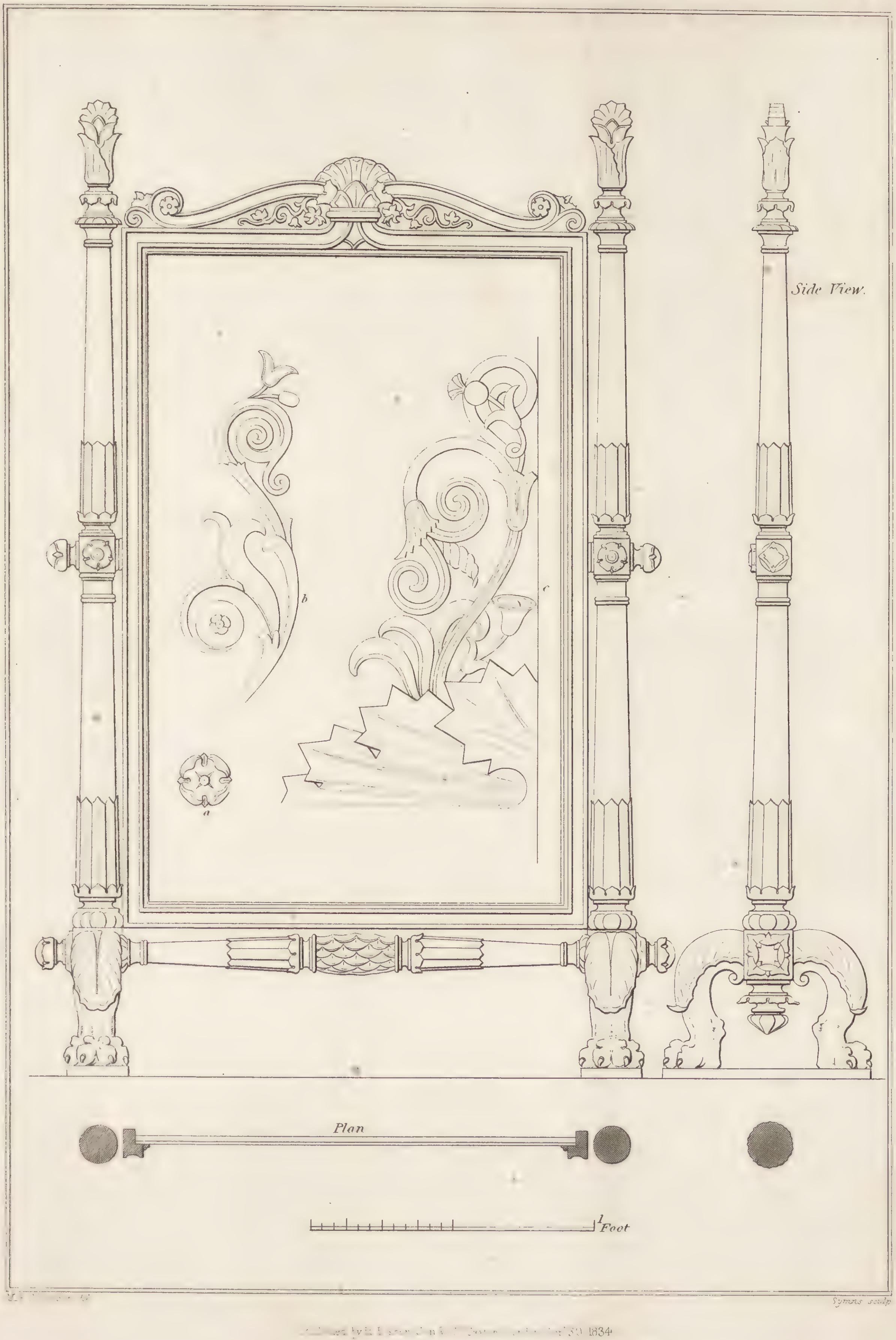
Published by H. Fisher, Son & Co. Caxton, London, 1834.

Cabinet and Looking Glass.



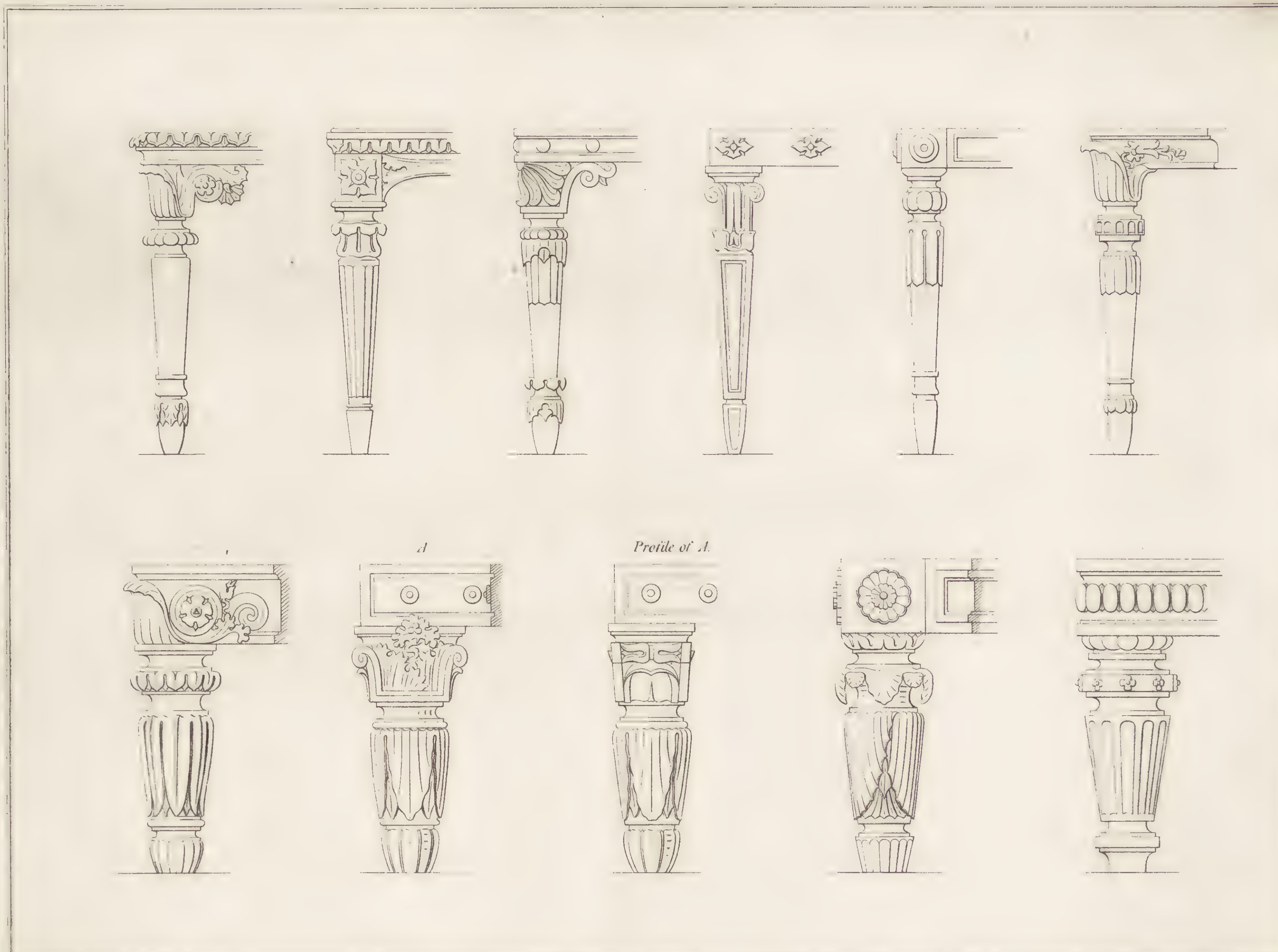
Published by Fisher, Son & Co.

Cheval Dressing-Glass.

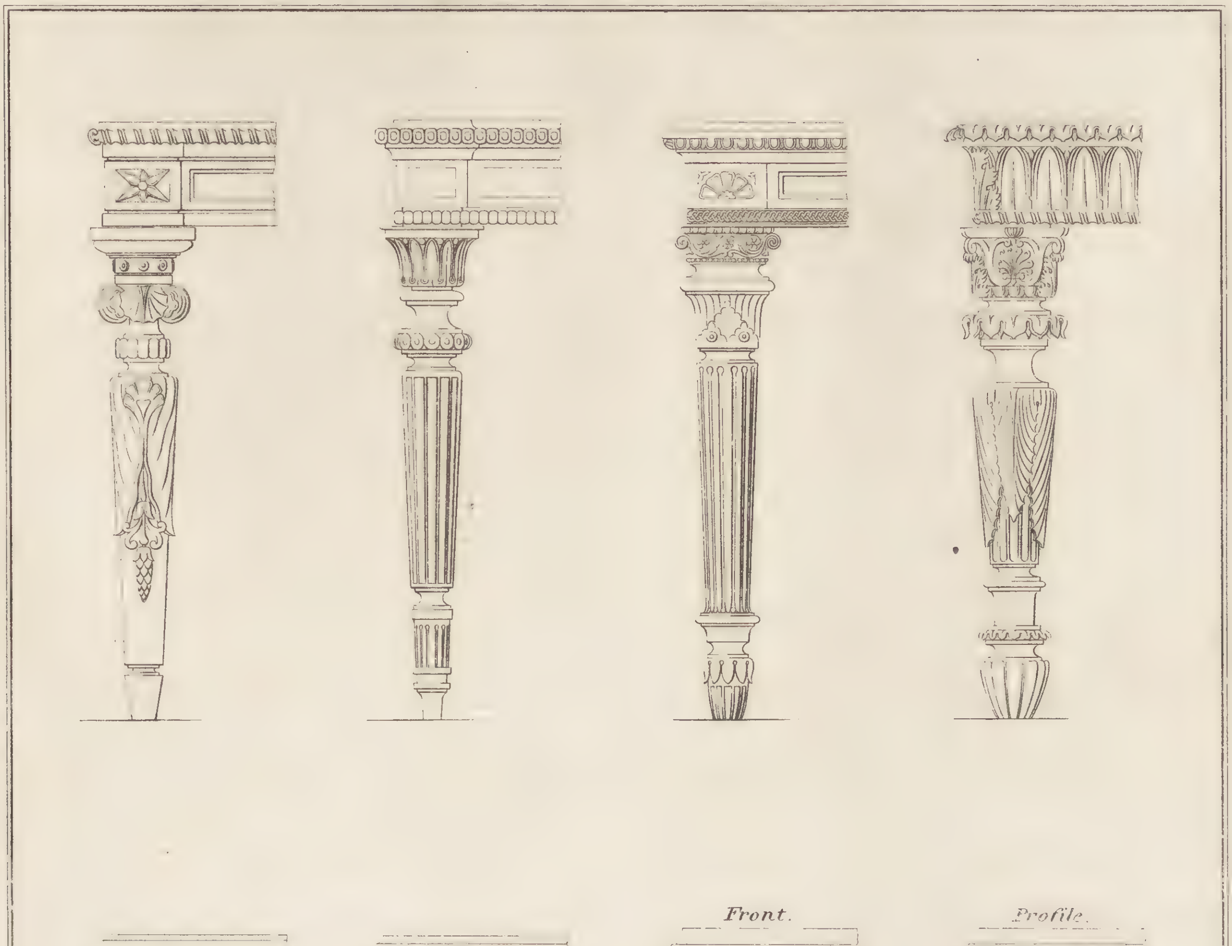


Symns sculp

Chair legs and Sofa legs with part of the Rails.



Side Board Legs & Rails.



Published by H. Fisher, Son, & Co. Caxton, London, [illegible]

TUSCAN ORDER.

Designed by M. A. Nicholson

Engraved on Steel by J. Shury.

Published by Fisher Son & Co. Caxton [illegible] 18[illegible]

IONIC ORDER

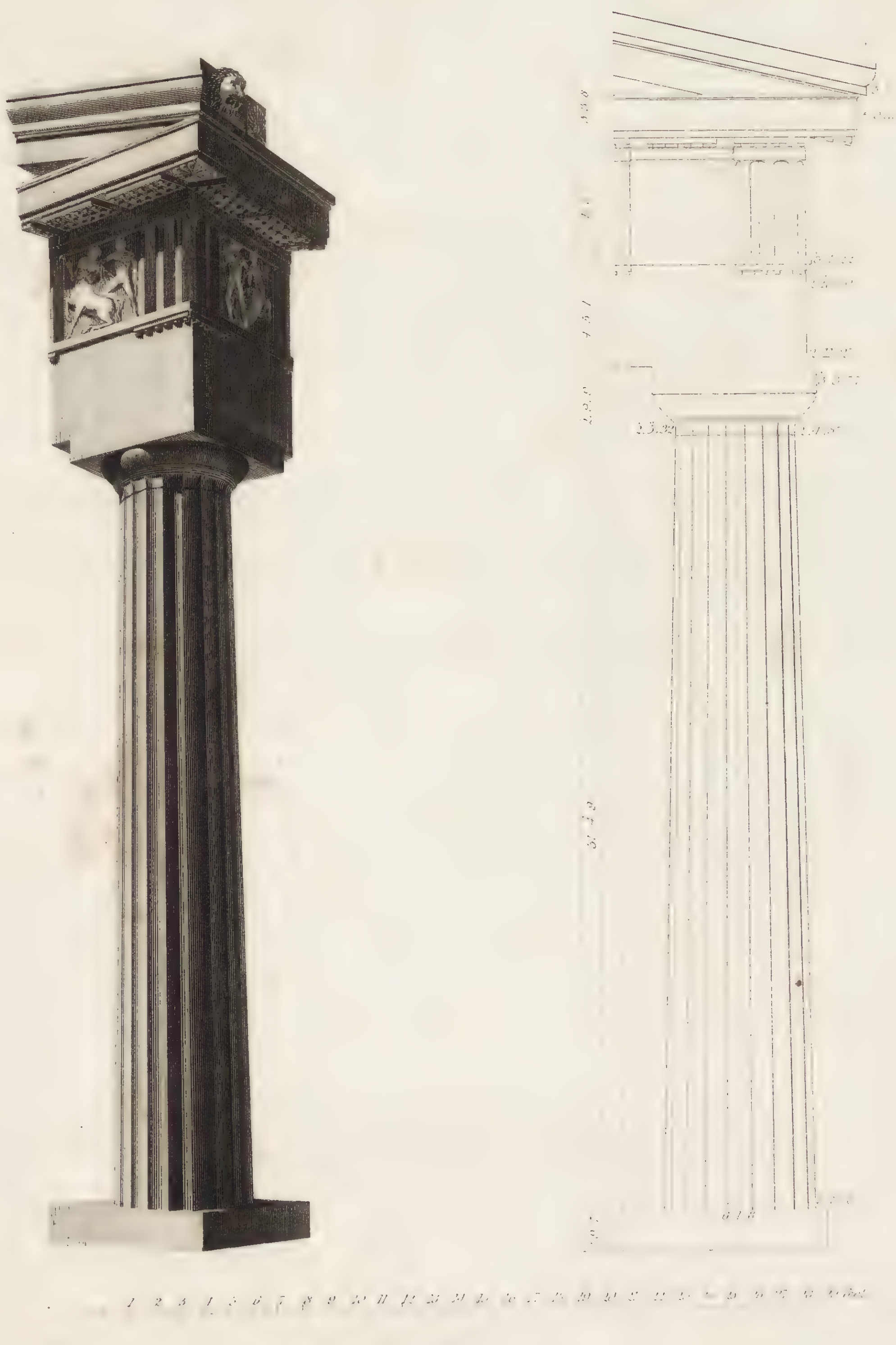
FROM THE TEMPLE OF MINERVA POLIAS AT PRIENE

In Perspective *Geometrical*

GRECIAN DORIC.

In Perspective

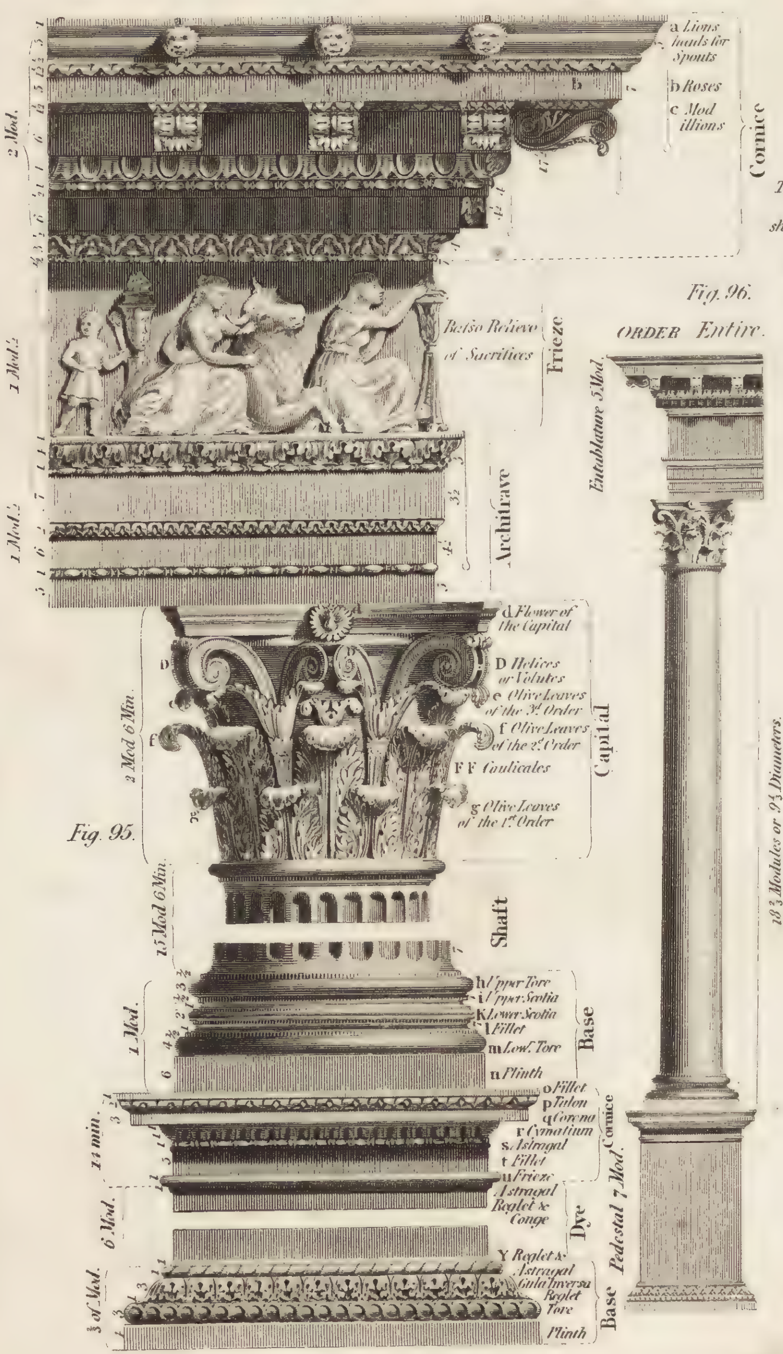
Geometrical



Designed by M.A.Nich

ARCHITECTURE, PL. III.

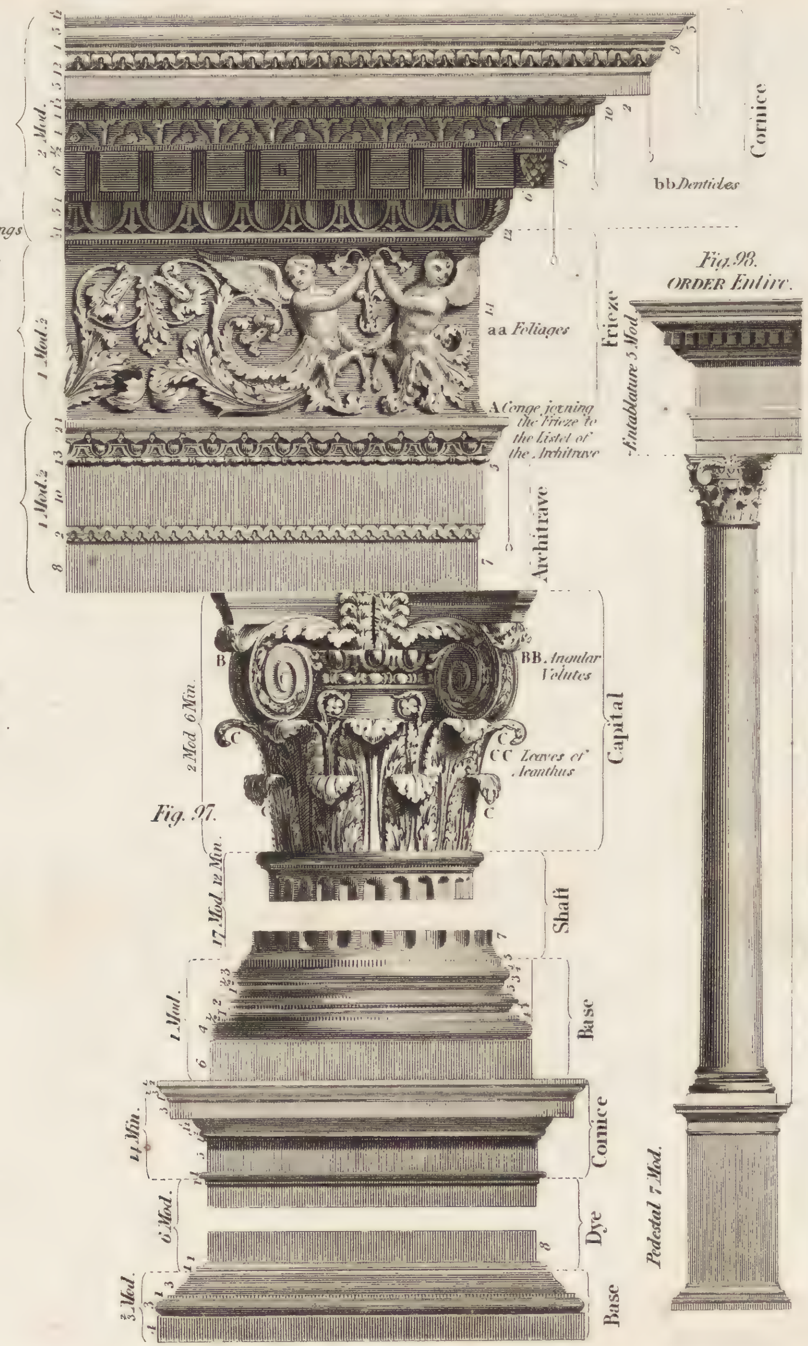
CORINTHIAN



The figures on the left hand shew the heights of the Mouldings Those on the right hand their Projections.

Module divided into 18 Minutes.

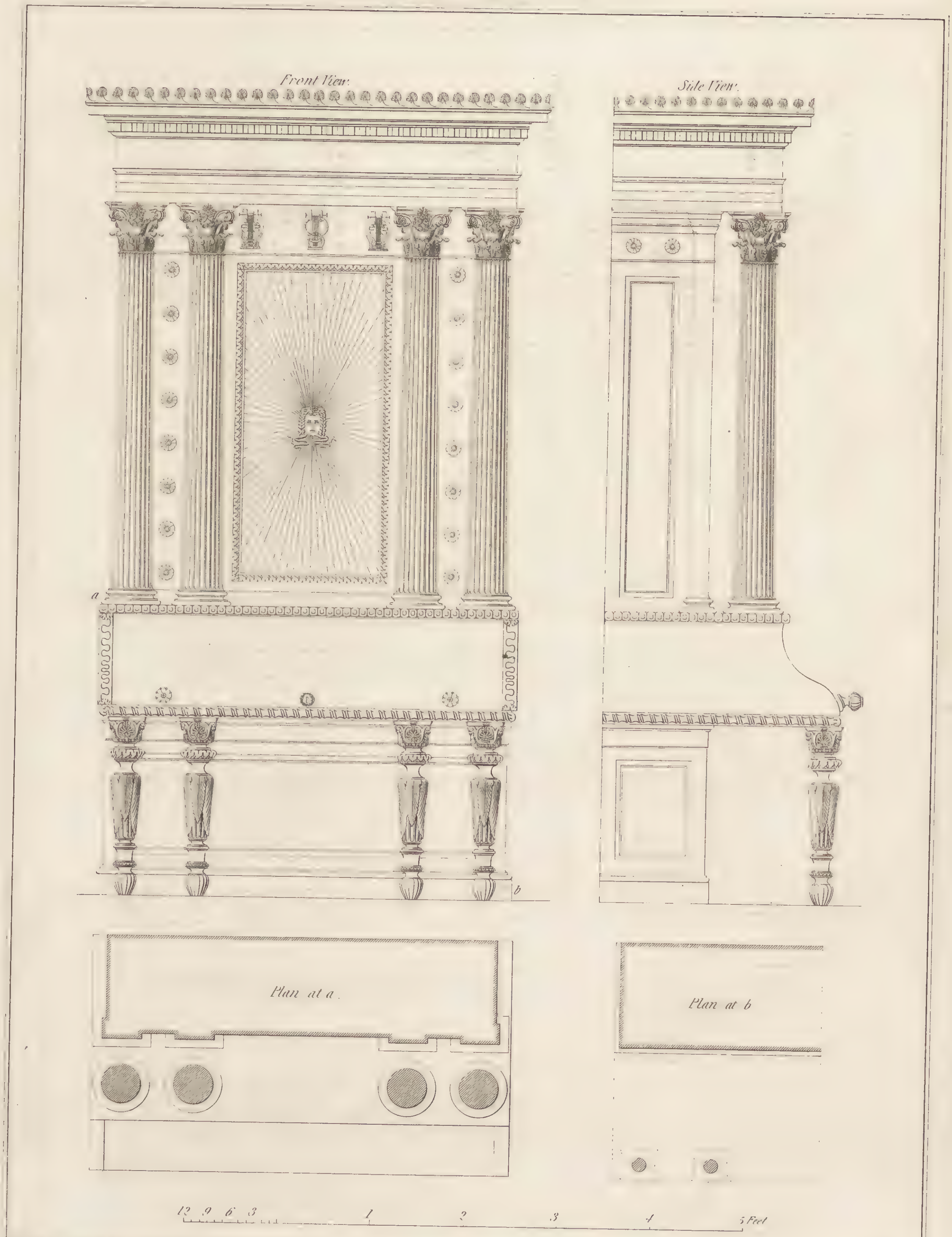
COMPOSITE



Revised by W. Ware, Esq.

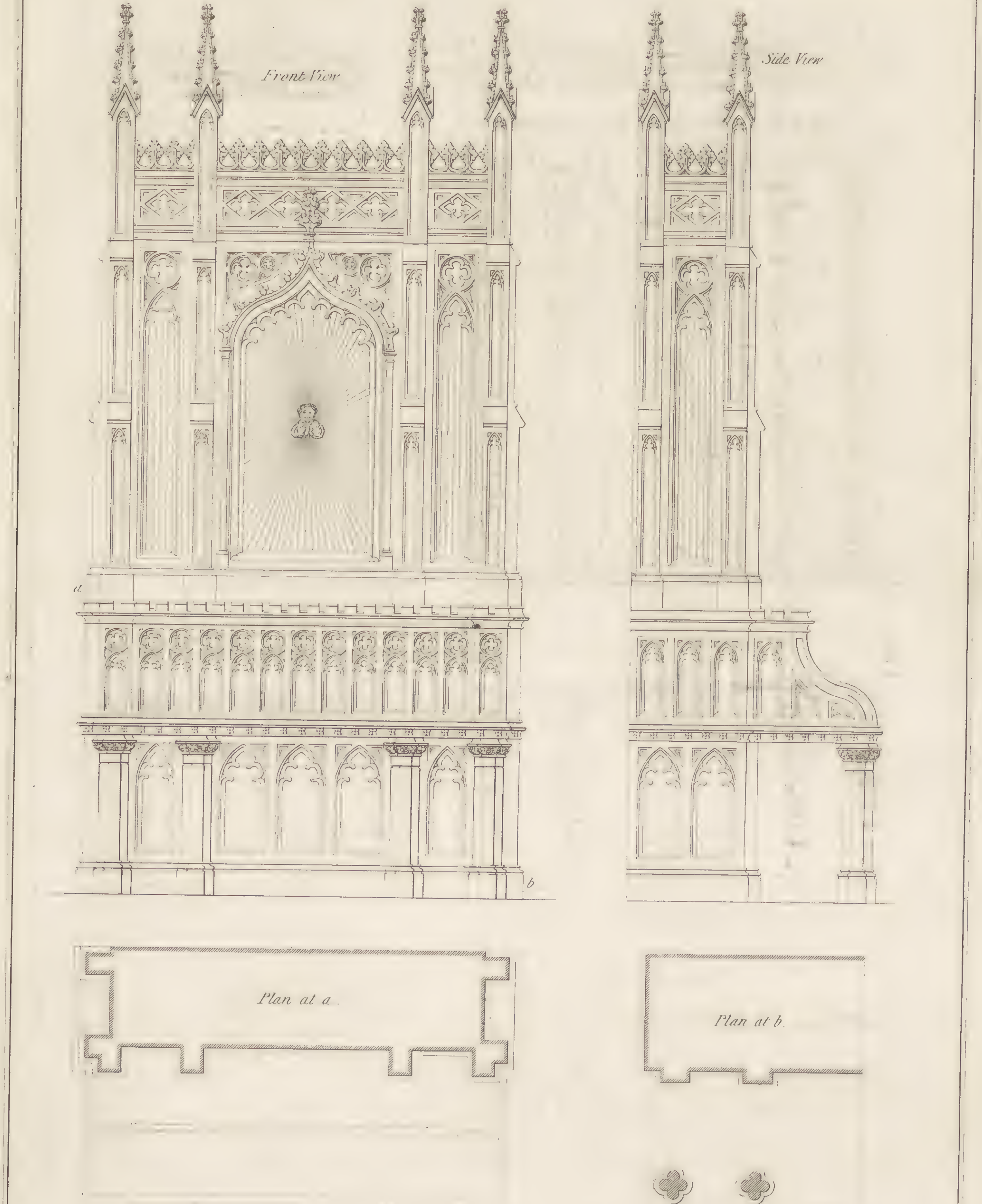
J. Lowry sculp.

Upright Piano Forte.



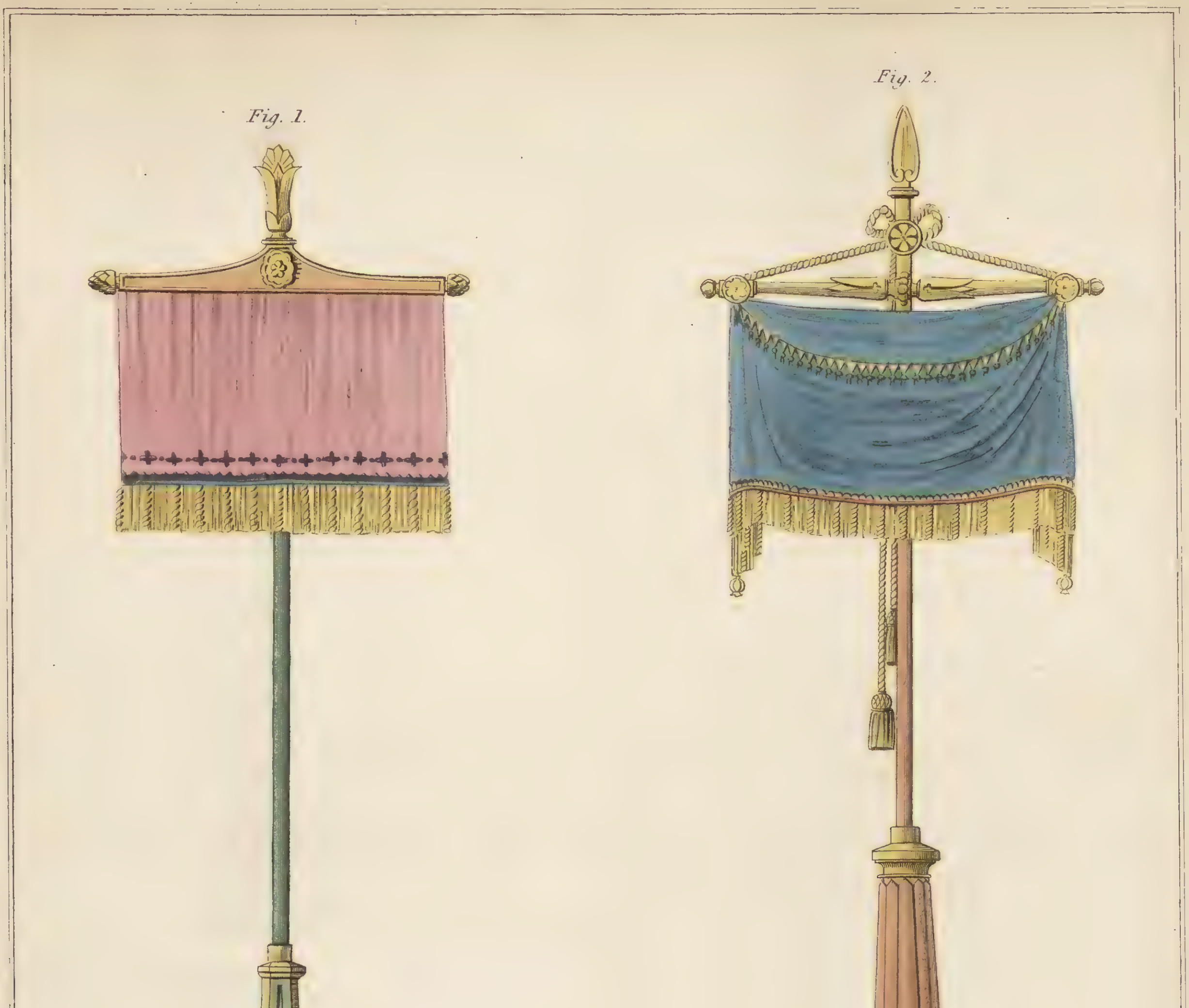
Published by H. Fisher Son & C° Caxton London

Upright Gothic Piano Forte.



Designed & Drawn by M. A. Nicholson

Fire Screens.



M.A. Nicholson. del.

J. Hensball sc.

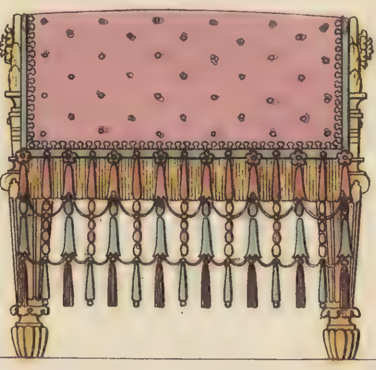
Published by Fisher, Son & C° Caxton, London, 1835.

Window Seats.

Fig. 1.

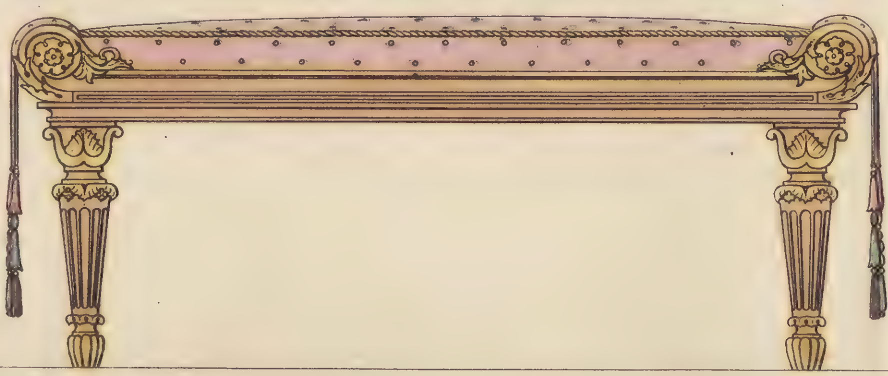
End view of Fig. 2.

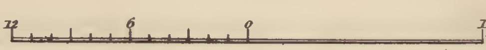
Horizontal Section of the Rail of Fig. 1.



Vertical Section of the Rail of Fig. 2.

Fig. 2.

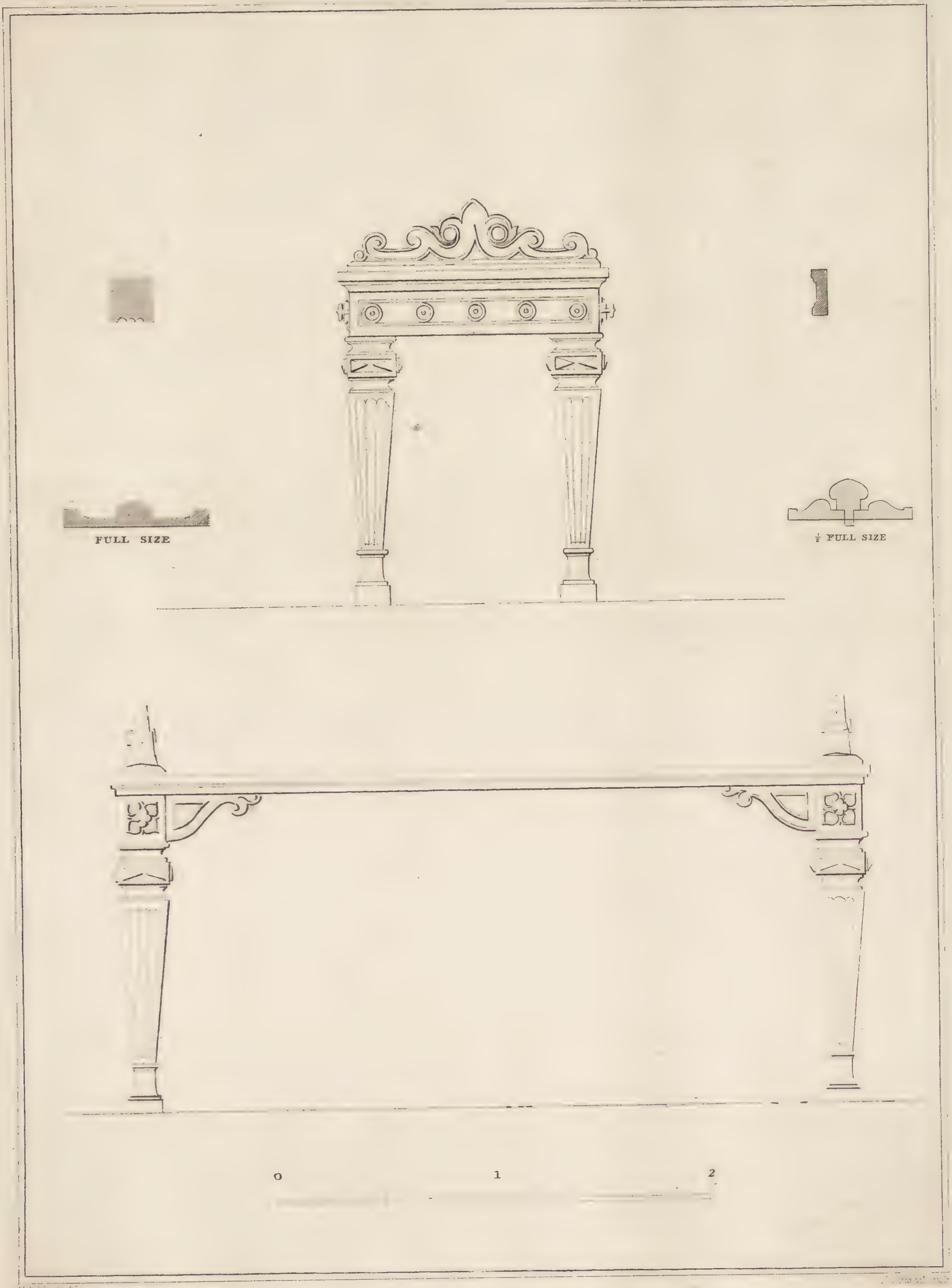




M. A. Nicholson, del.

Published by Fisher, Son & Co. Caxton, London, June 1.1832

A Hall Seat.

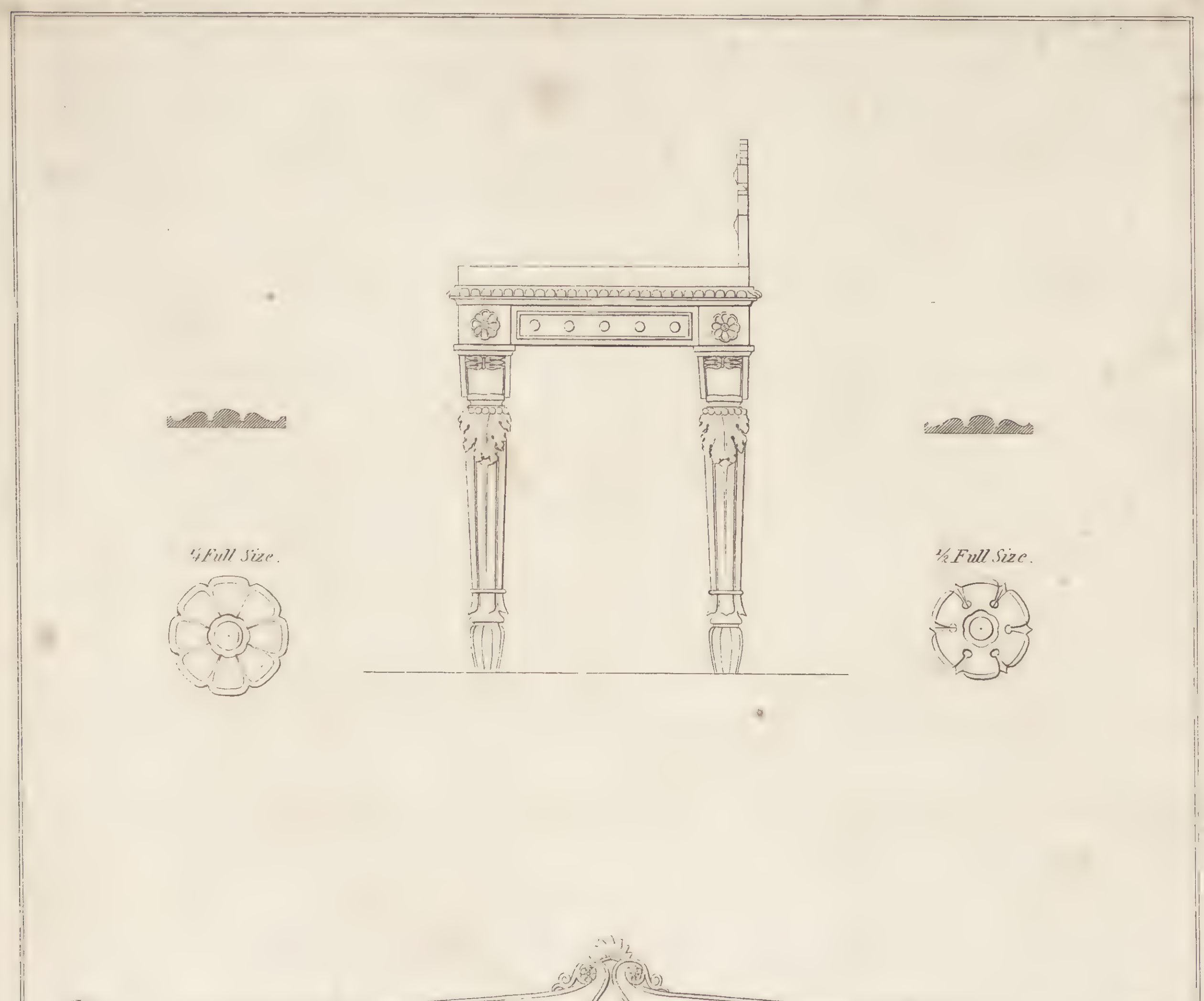


Published by Fisher, Son & C° Caxton, London 1835

Side Board.

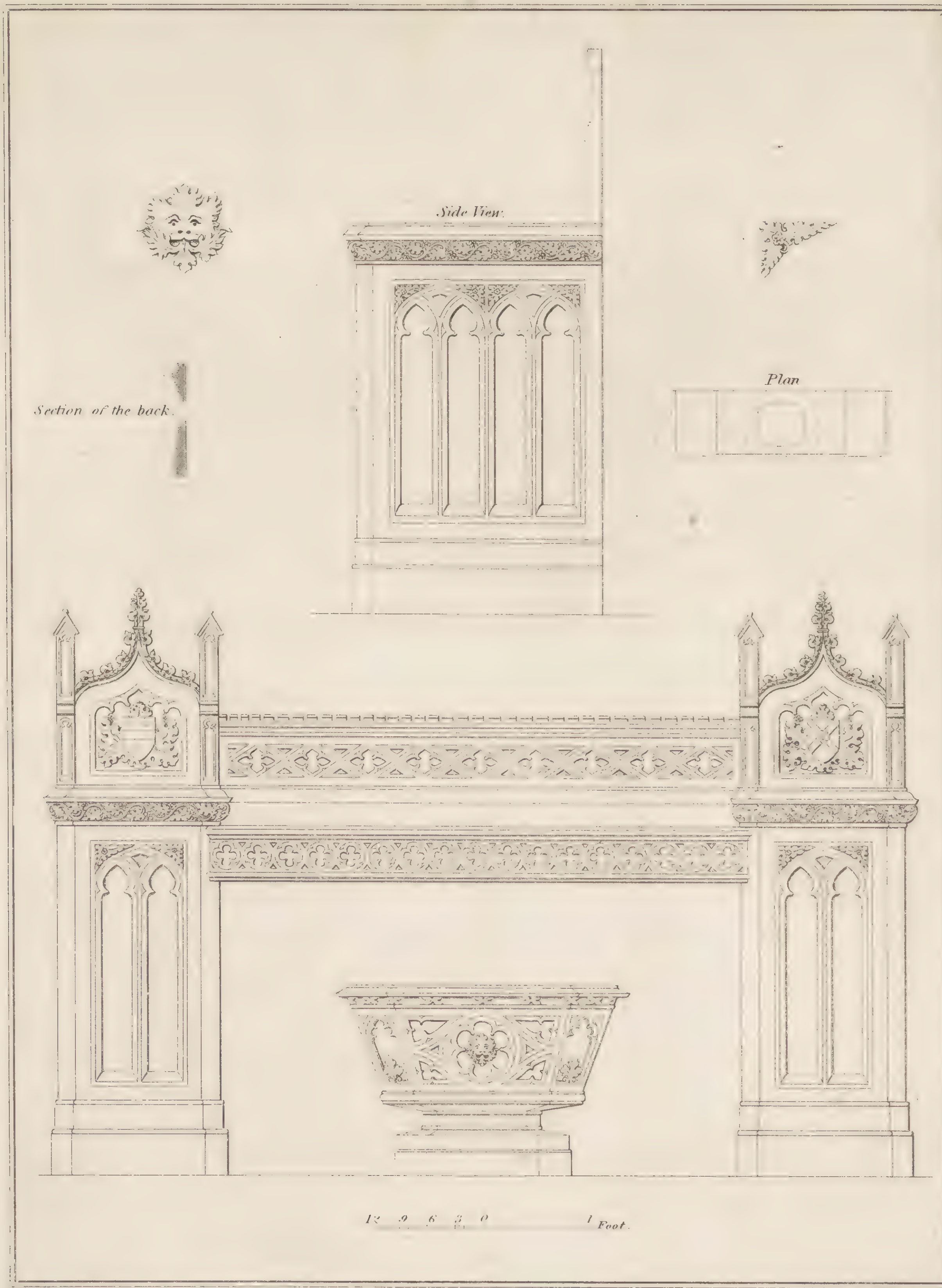
Published by Fisher Son & Co. Caxton, London 1826

Sideboard.



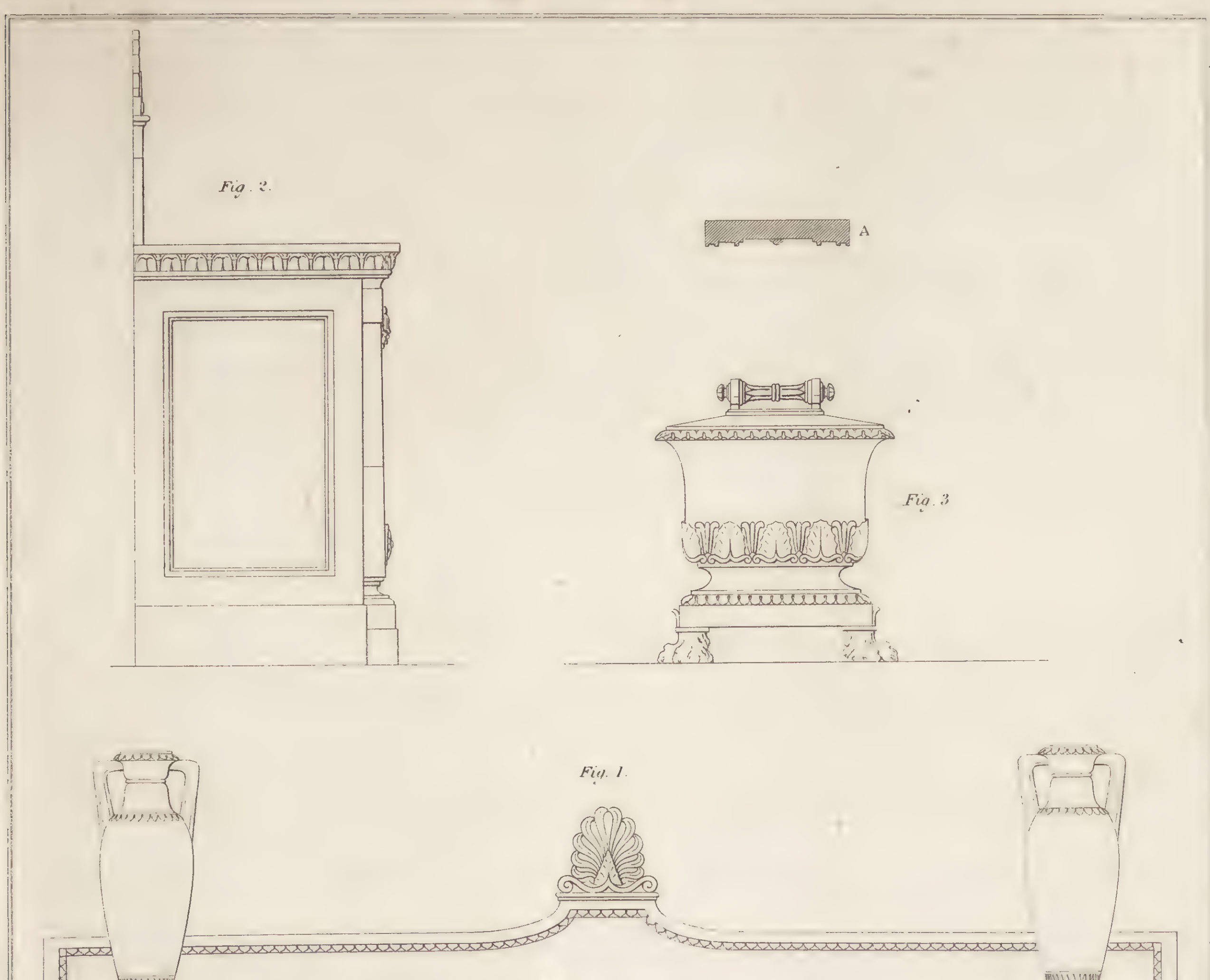
Published by Fisher, Son & C° Caxton, London, Jan. 29, 1834.

Gothic Side Board.



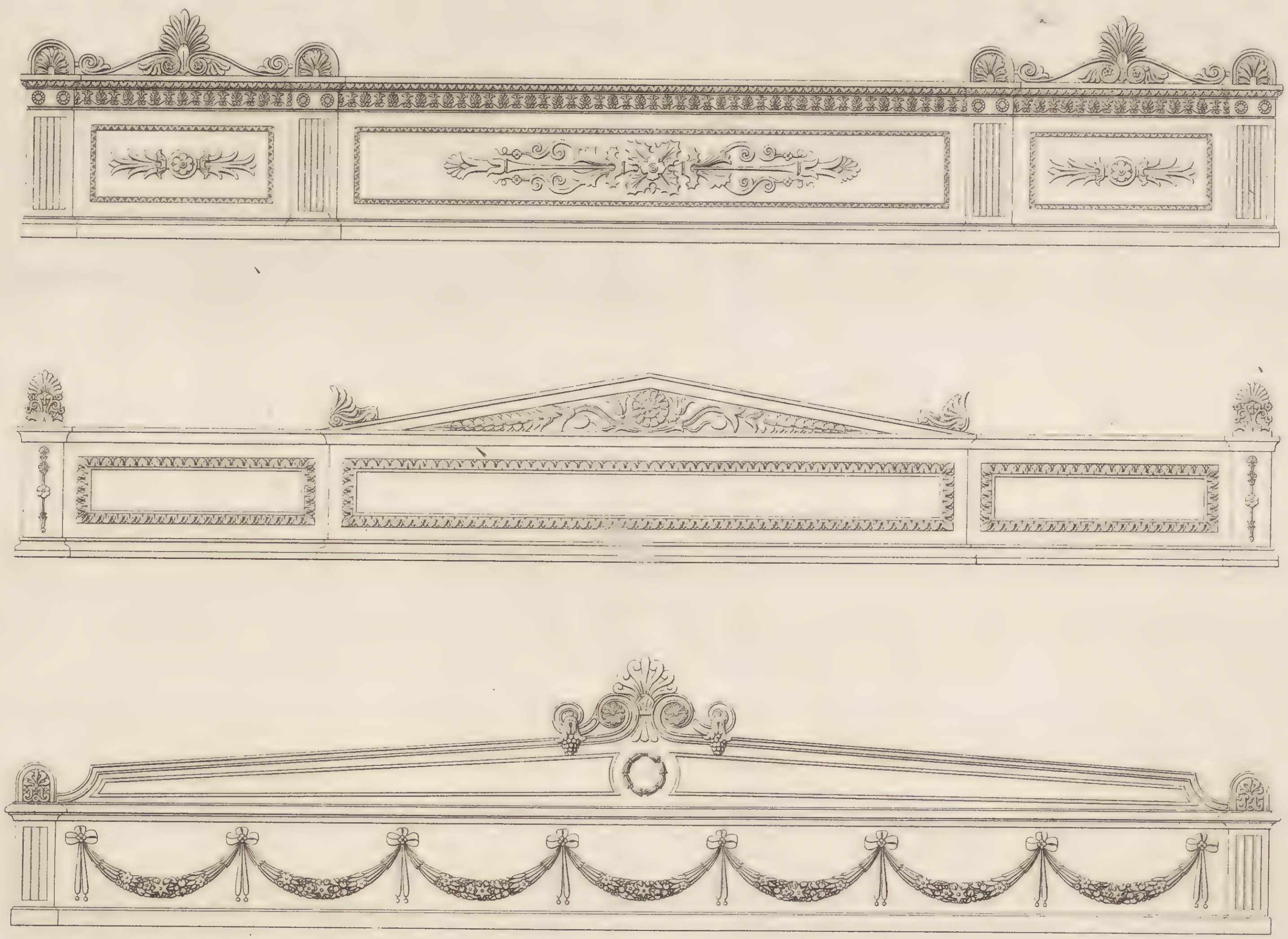
Published by ... Fisher Son & Co. ... London Sep 1834.

Side Board and Celerett.



Published by Fisher Son & Cº Caxton London 1835

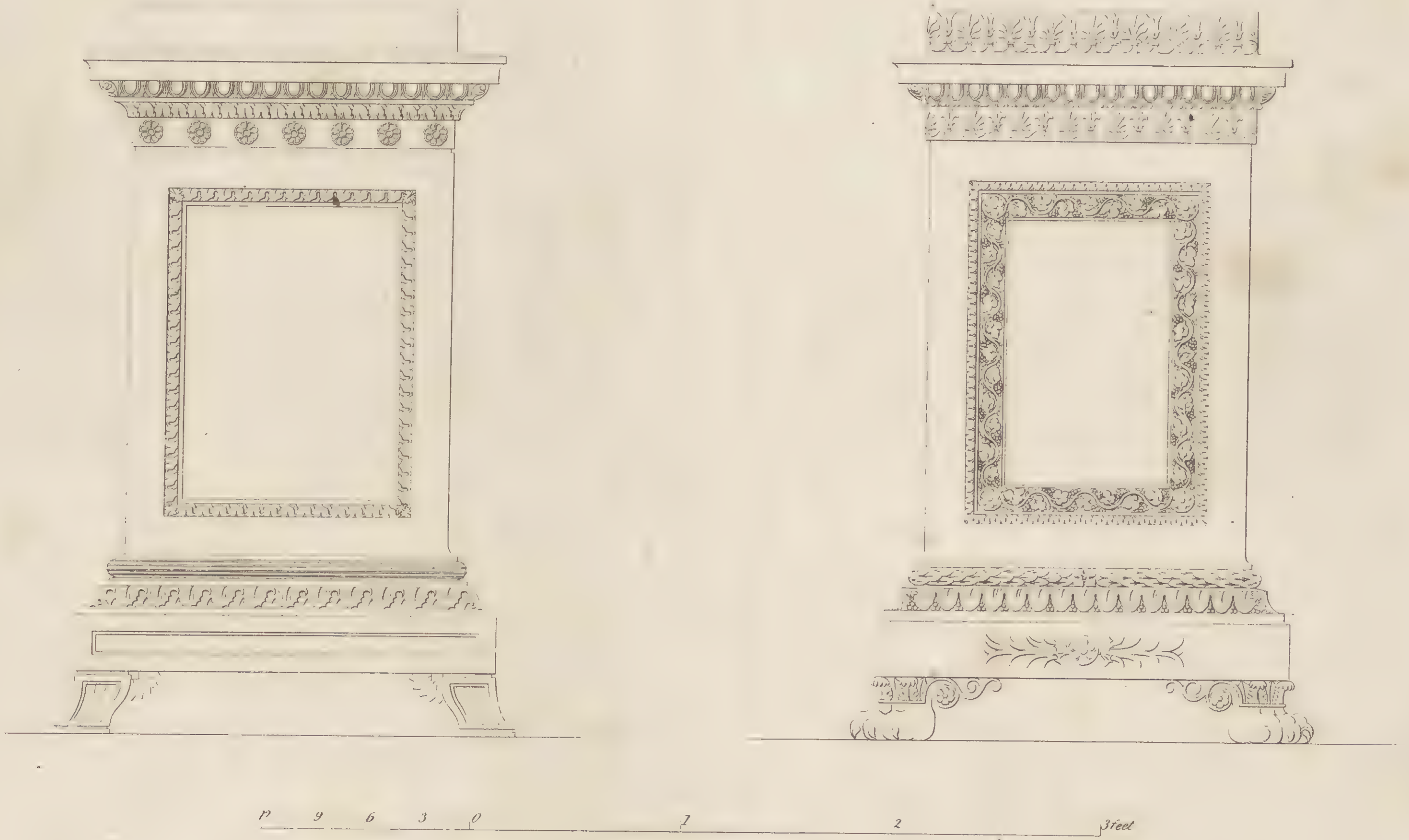
For Sideboard Backs, &c.



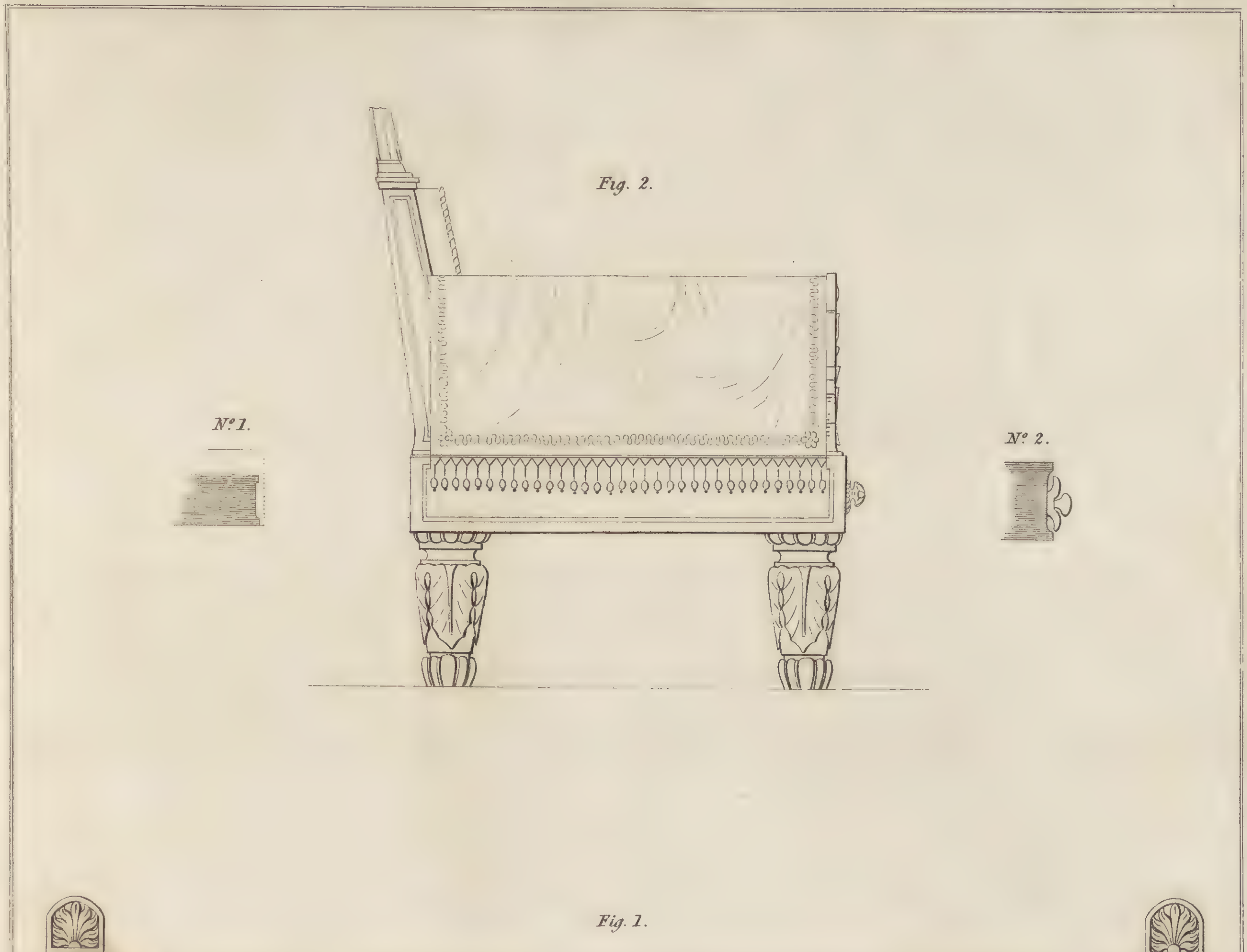
Designed & Drawn by M. A. Nicholson.

Published by Fisher Son & Co. Caxton London, 1834.

Pedestals for Sideboard Tables.



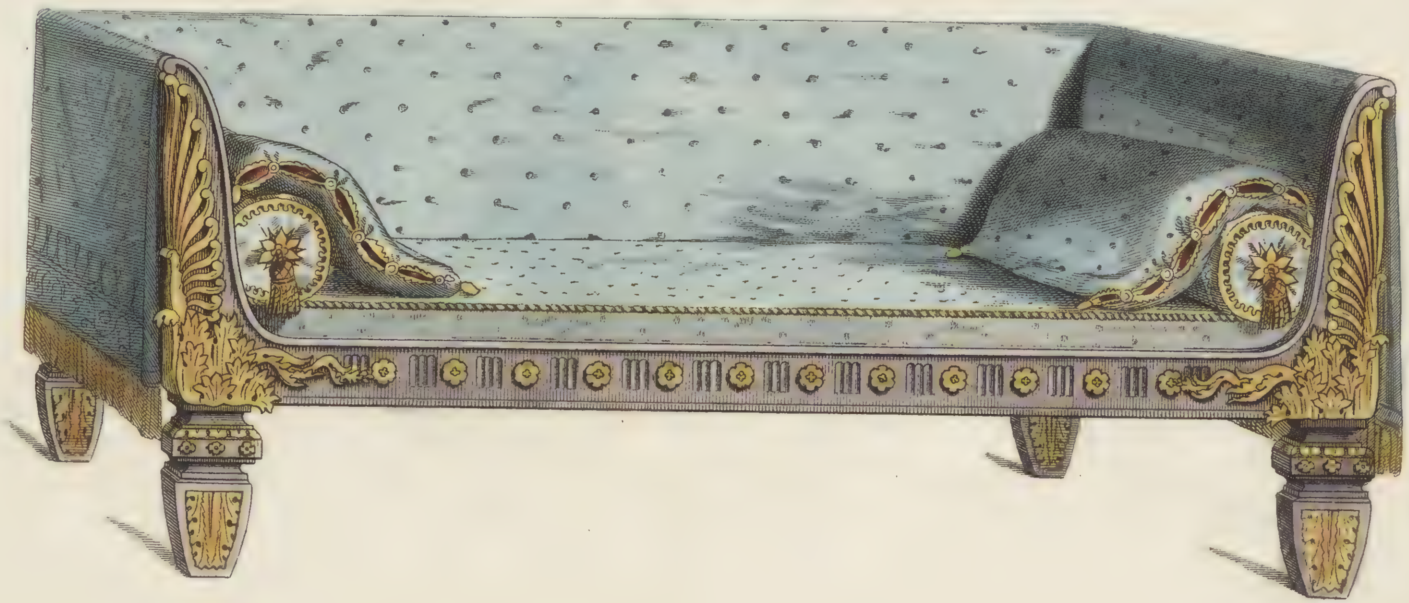
Sofa.



M. A. Nicholson, del. J. Allen sc.

Published by Fisher Son & Cº Caxton, London May 1826.

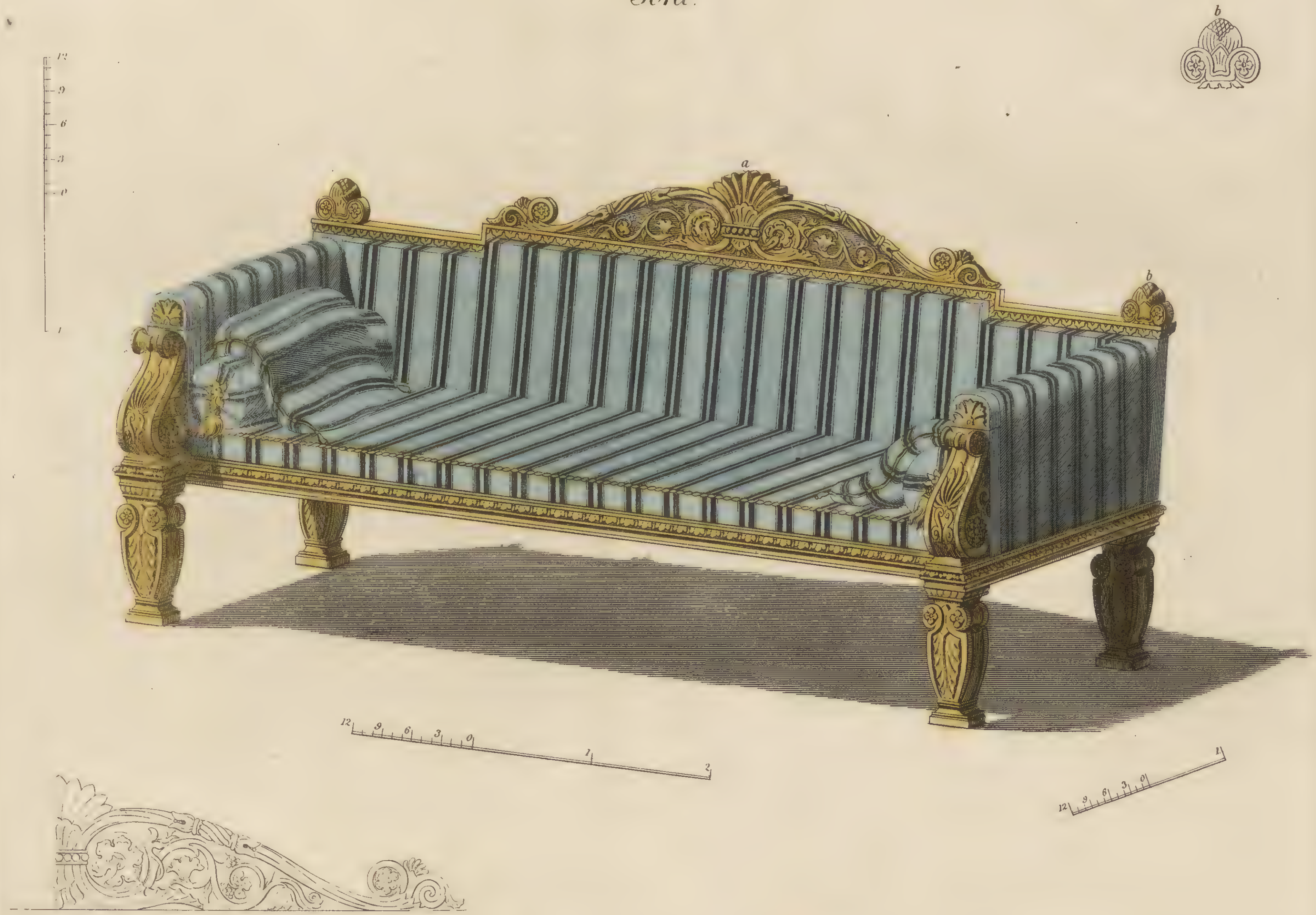
Sofa.



M.A. Nicholson, del. — S. Williams, sc.

Published by Fisher, Son & Co Caxton, London, 1826.

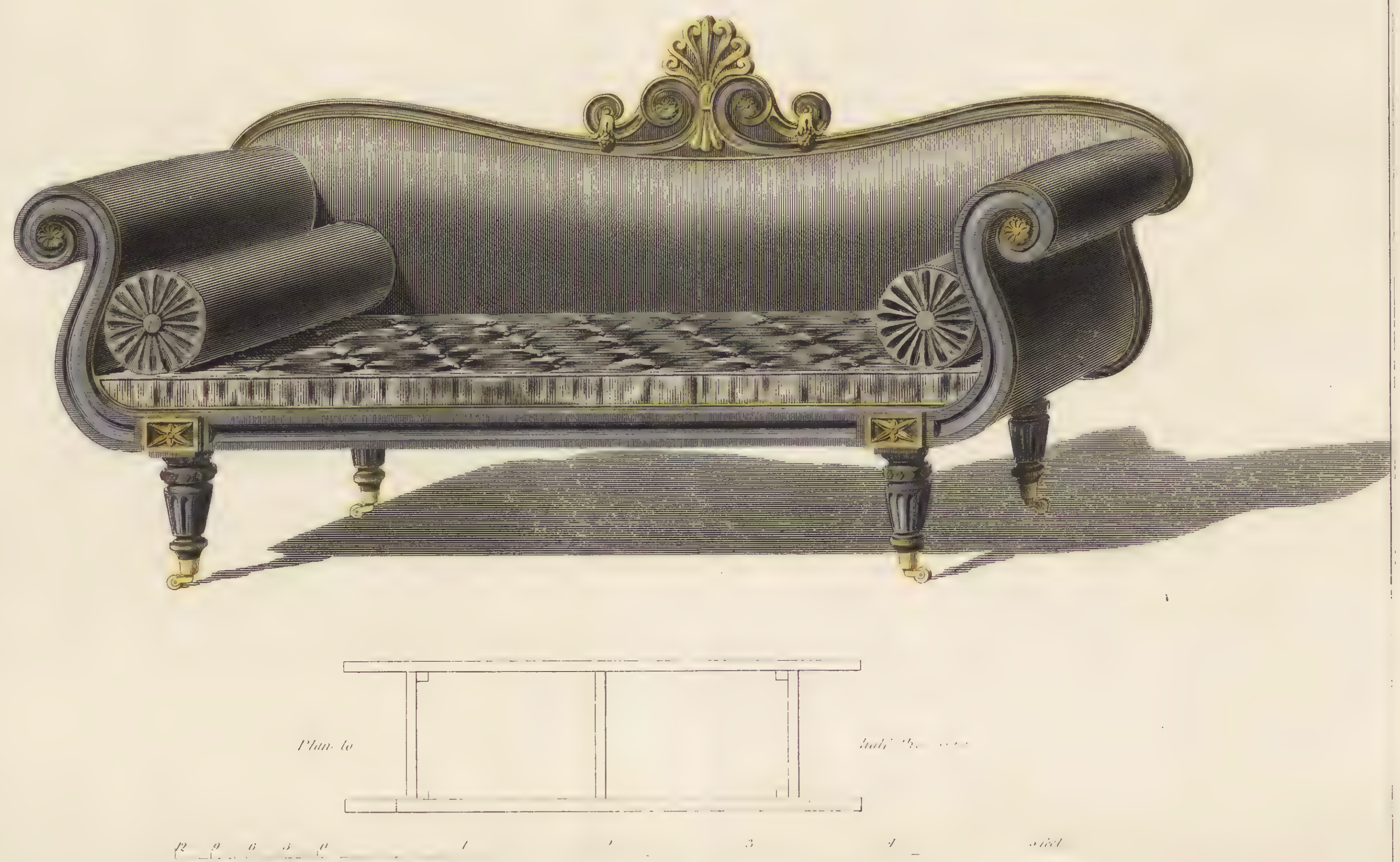
Sofa.



Ornament at a. enlarged

Simmons sculp

Sofa.



Designed & Drawn by M. A. Nicholson.

Published by Fisher, Son & C° Caxton, London, 1835.

Stools.

Fig. 1.

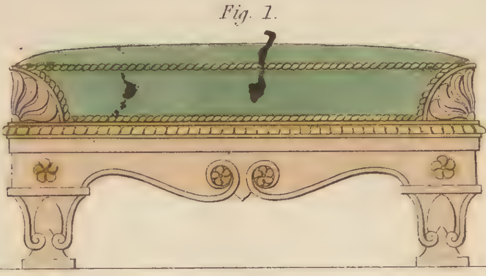


Fig. 2.

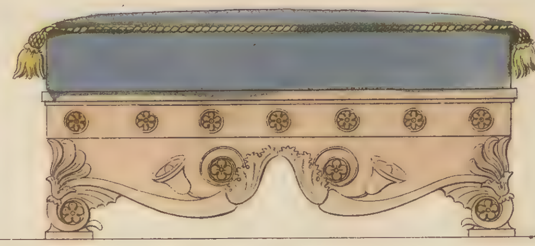
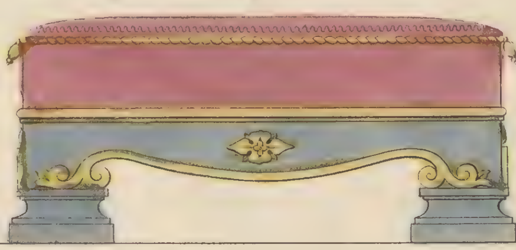
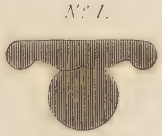


Fig. 3.

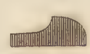


N° 1.



Full size.

N° 2.



Full size.

N° 3.

Full size.

Fig. 4.

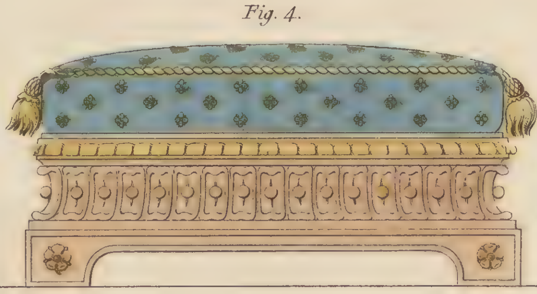
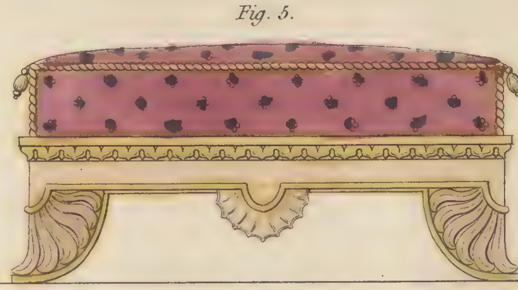


Fig. 5.

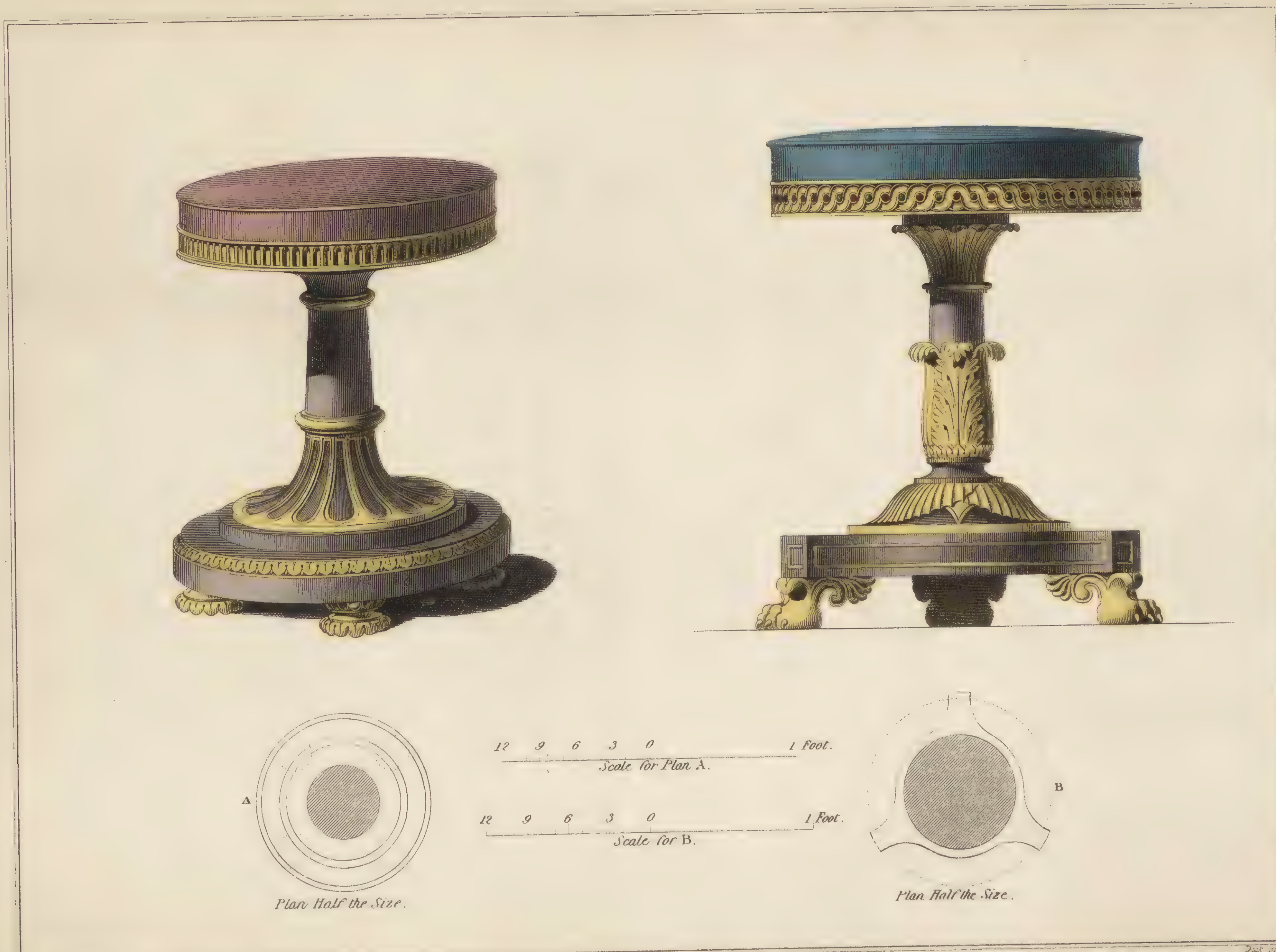


M.A. Nicholson del.

H. Sw[illegible] sc.

[illegible] Fisher [illegible] & C° Caxton London [illegible]

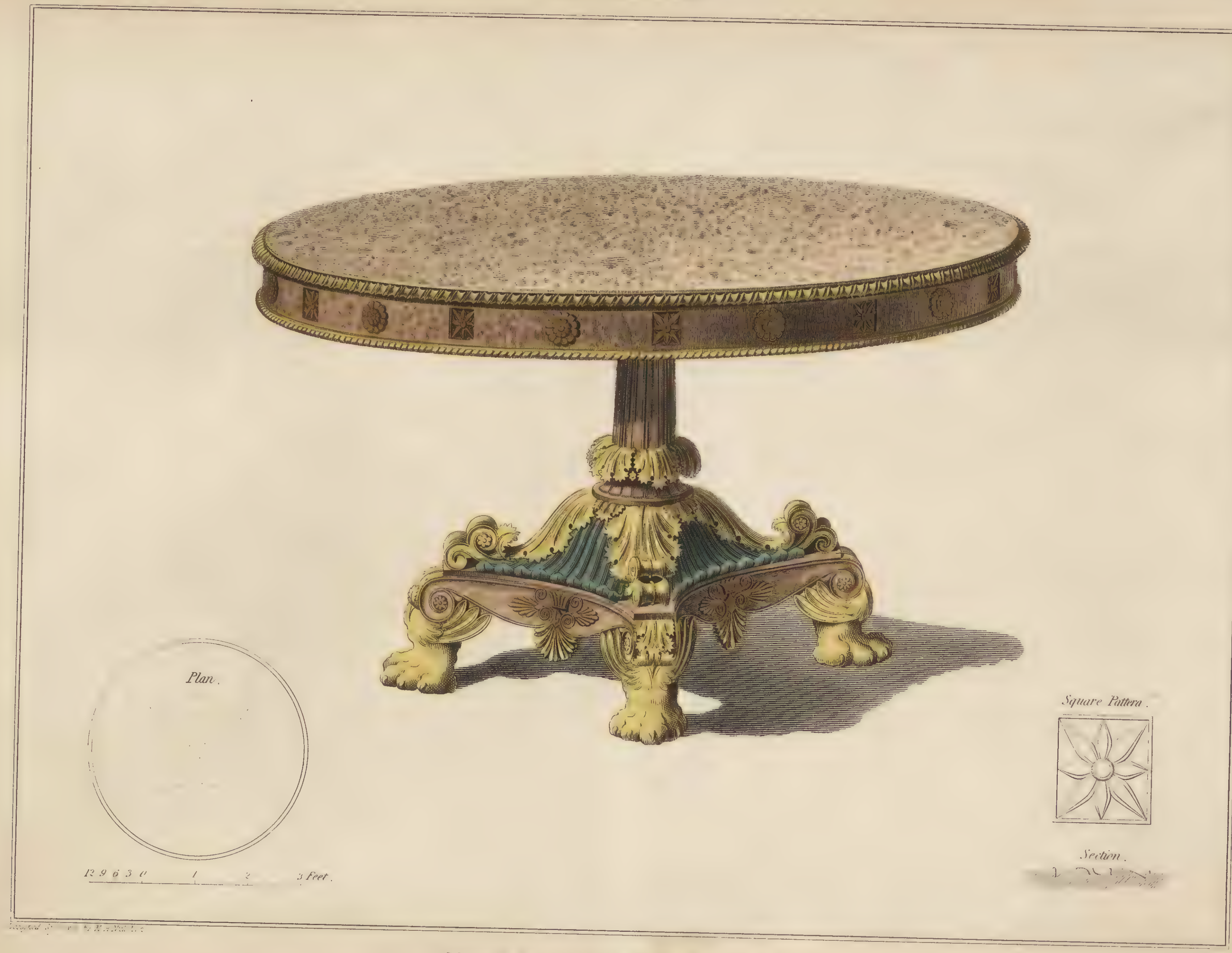
Music Stools.



Designed by M. A. Nicholson

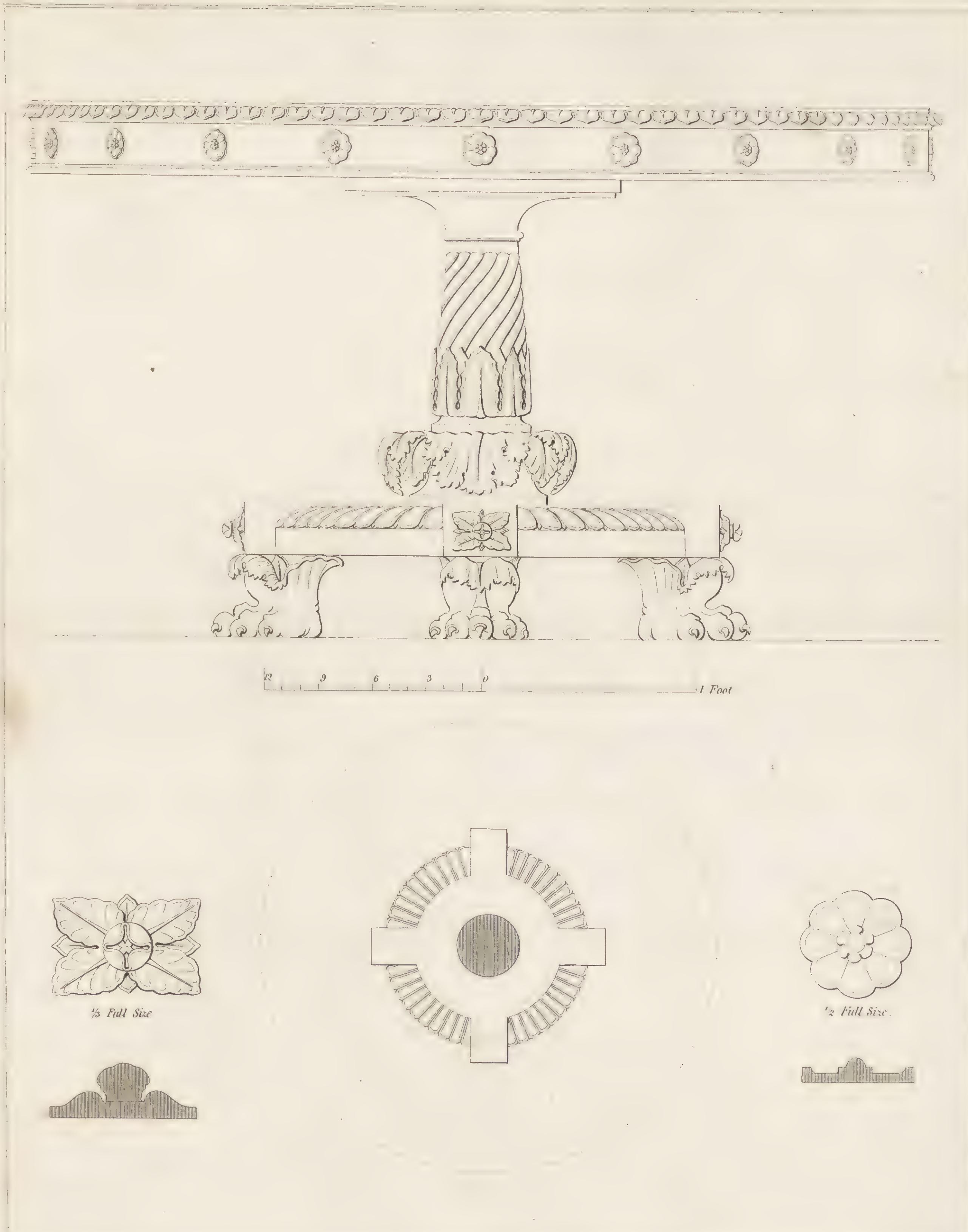
Published by Fisher Son & C° Caxton London Jan 1835.

Circular Table.

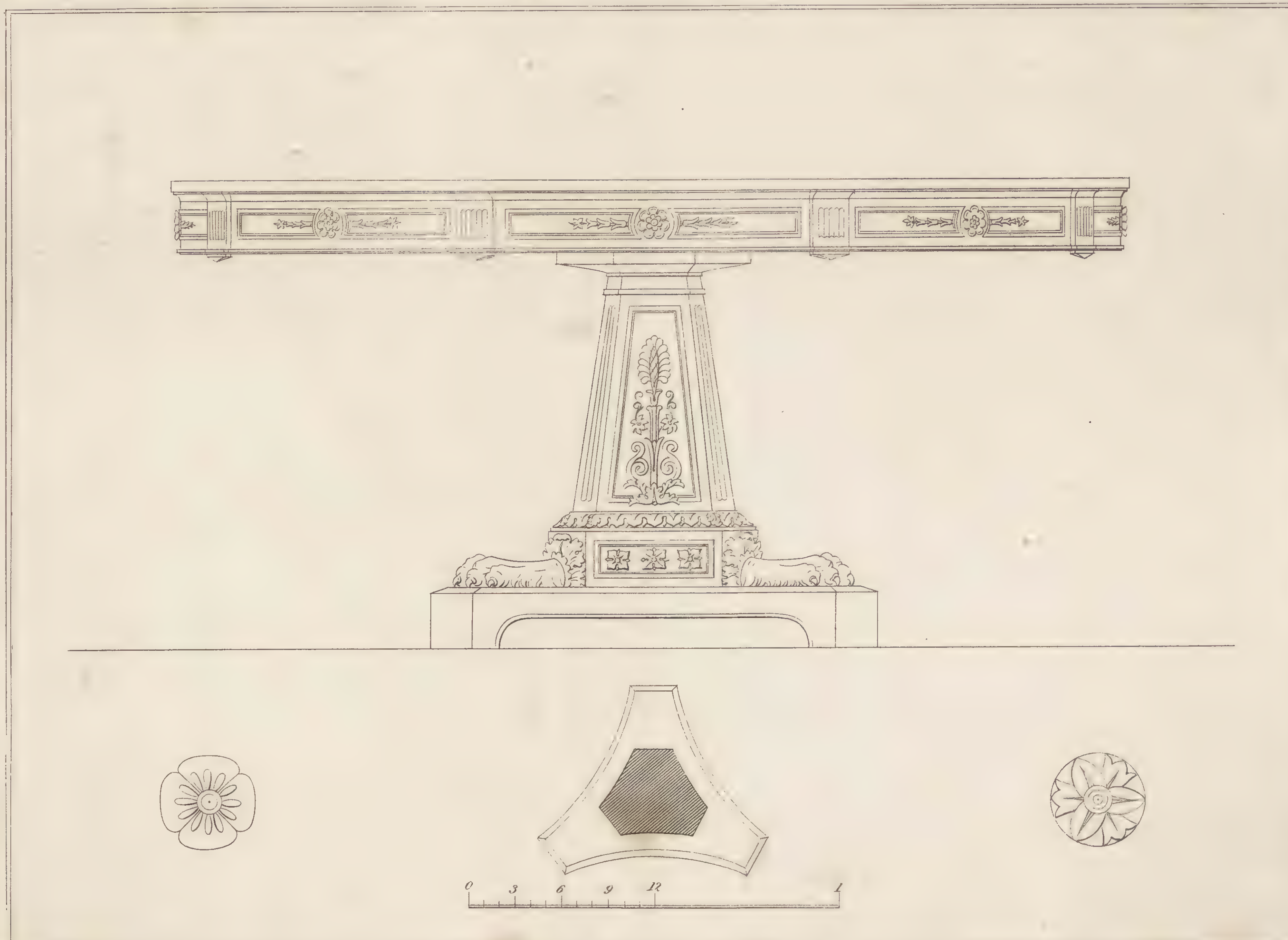


Published by Fisher, Son & Co. Caxton London Jan 1834.

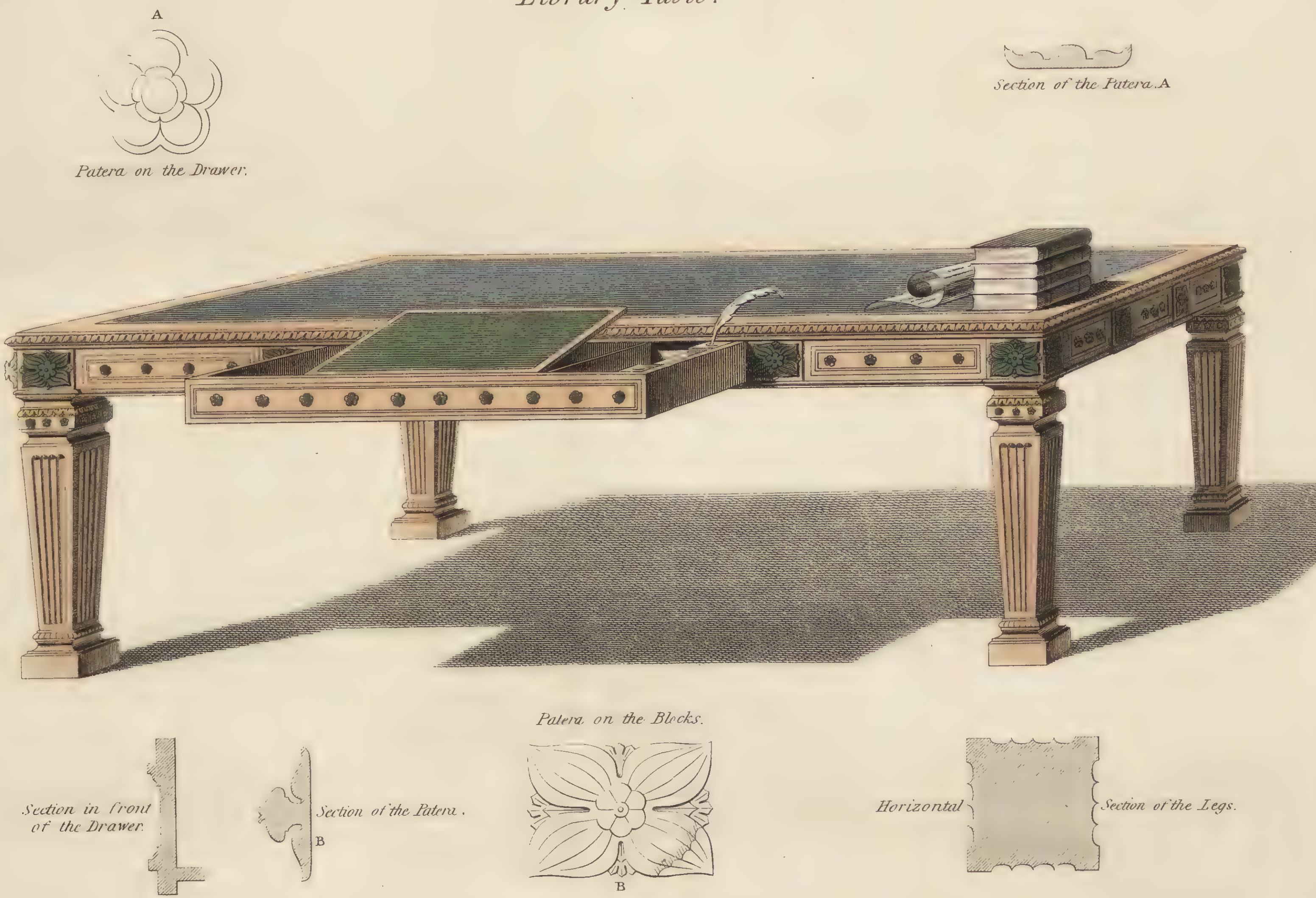
Circular Table.



Circular Library Table.



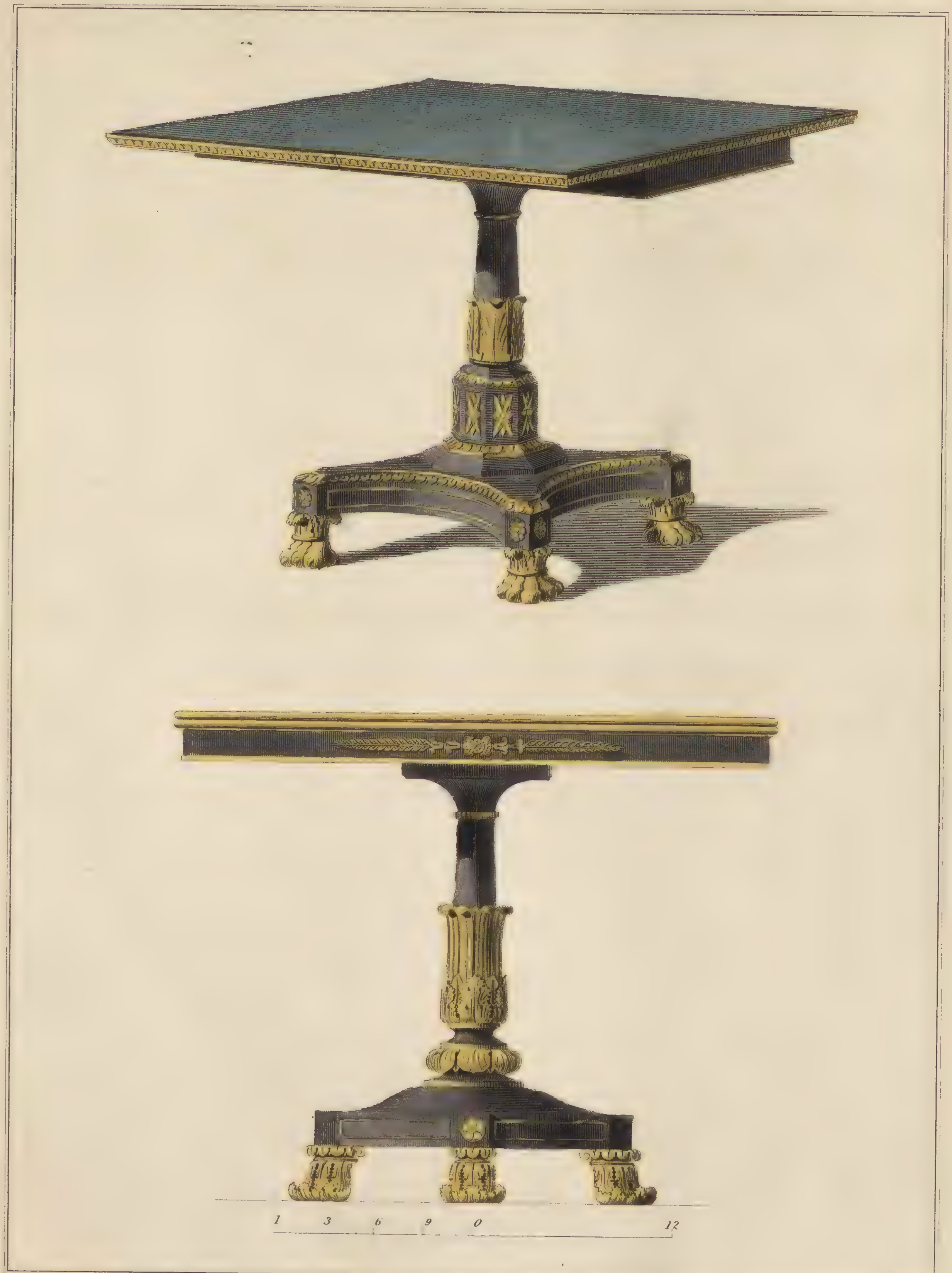
Library Table.



A. Dick sc.

Published by Fisher Son & C° Caxton London, May. 1834.

Card Tables.



Designed & Drawn by M.A. Nicholson — *A. Dick sculp*

Published by Fisher, Son & Co. Caxton, London, Dec. 1834

Card Tables.

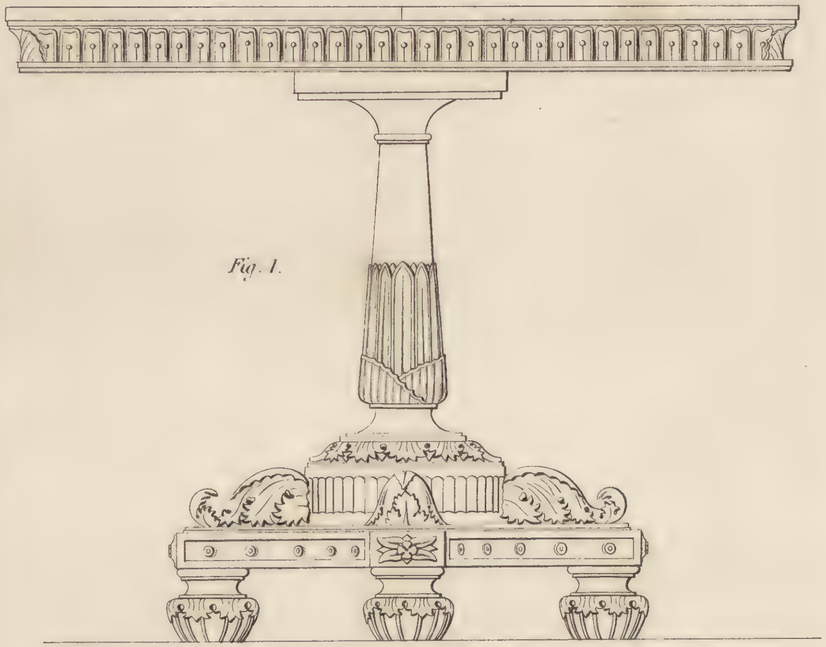


Fig. 1.

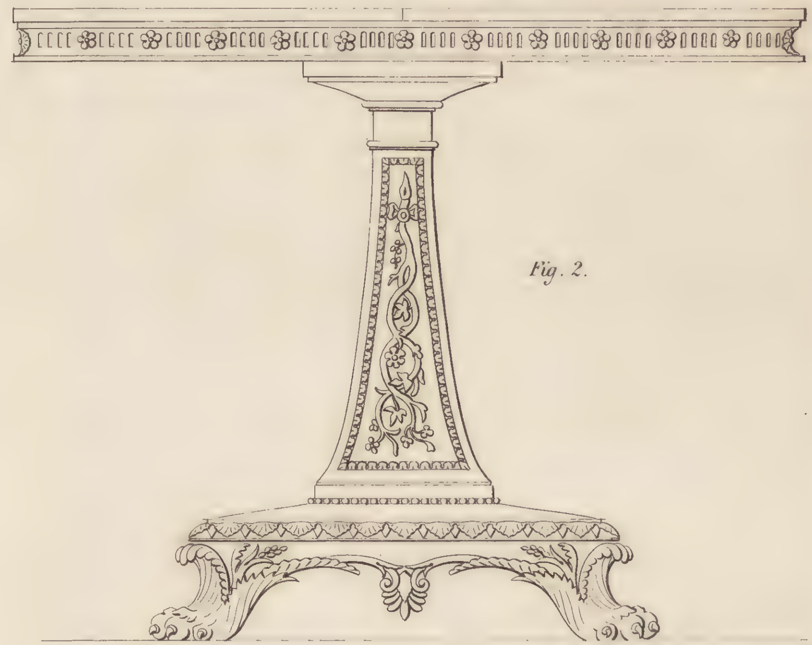
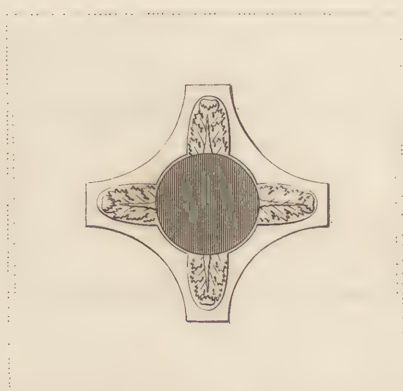


Fig. 2.

Fig. 3.



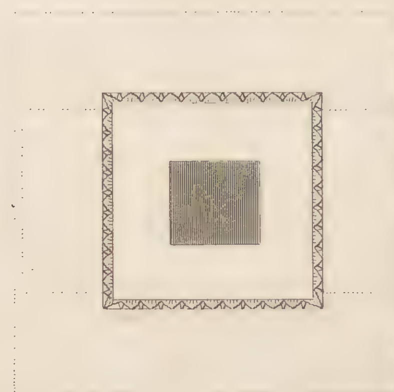


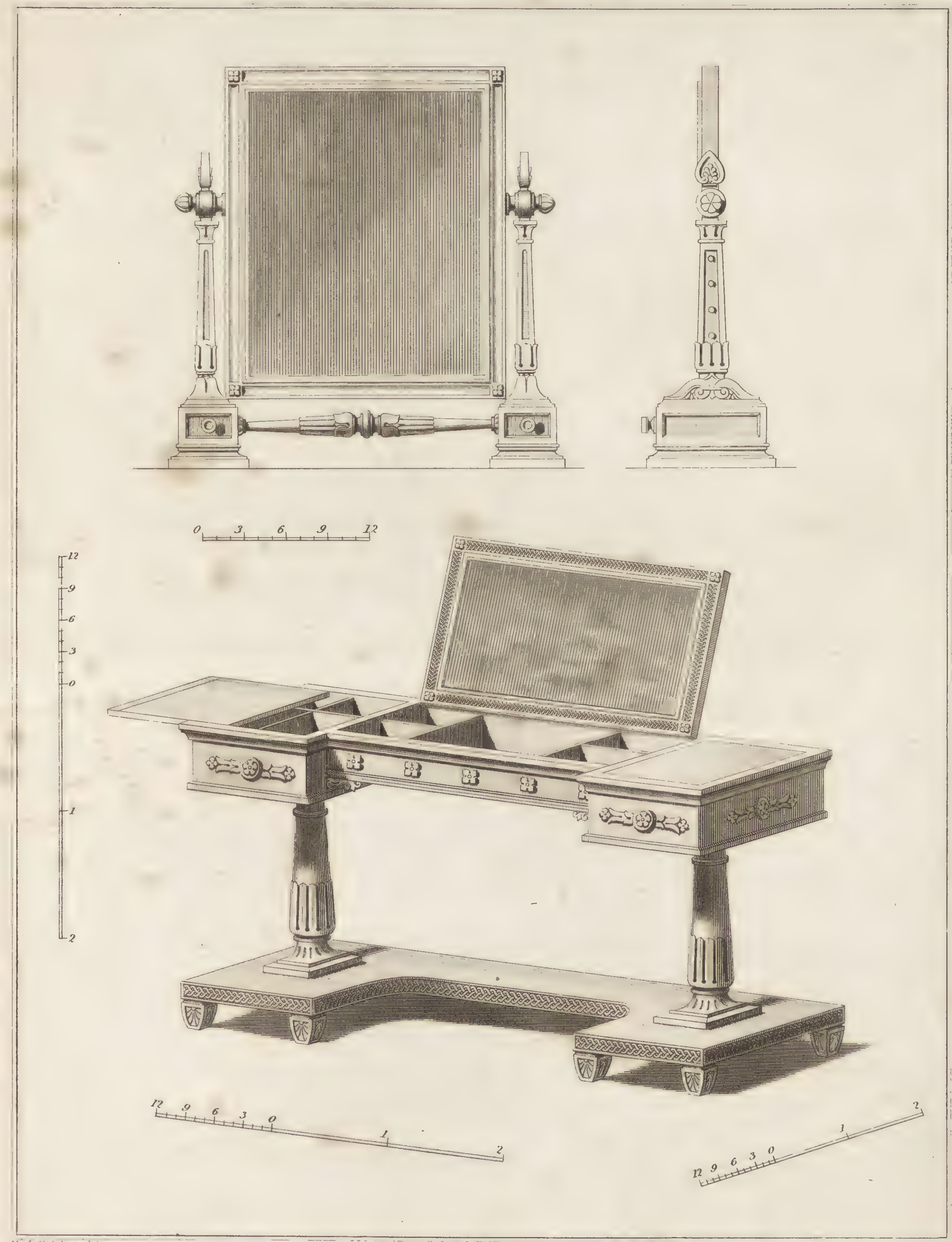
Fig. 4.

M. A. Nicholson, del.

J. Allen, sculp.

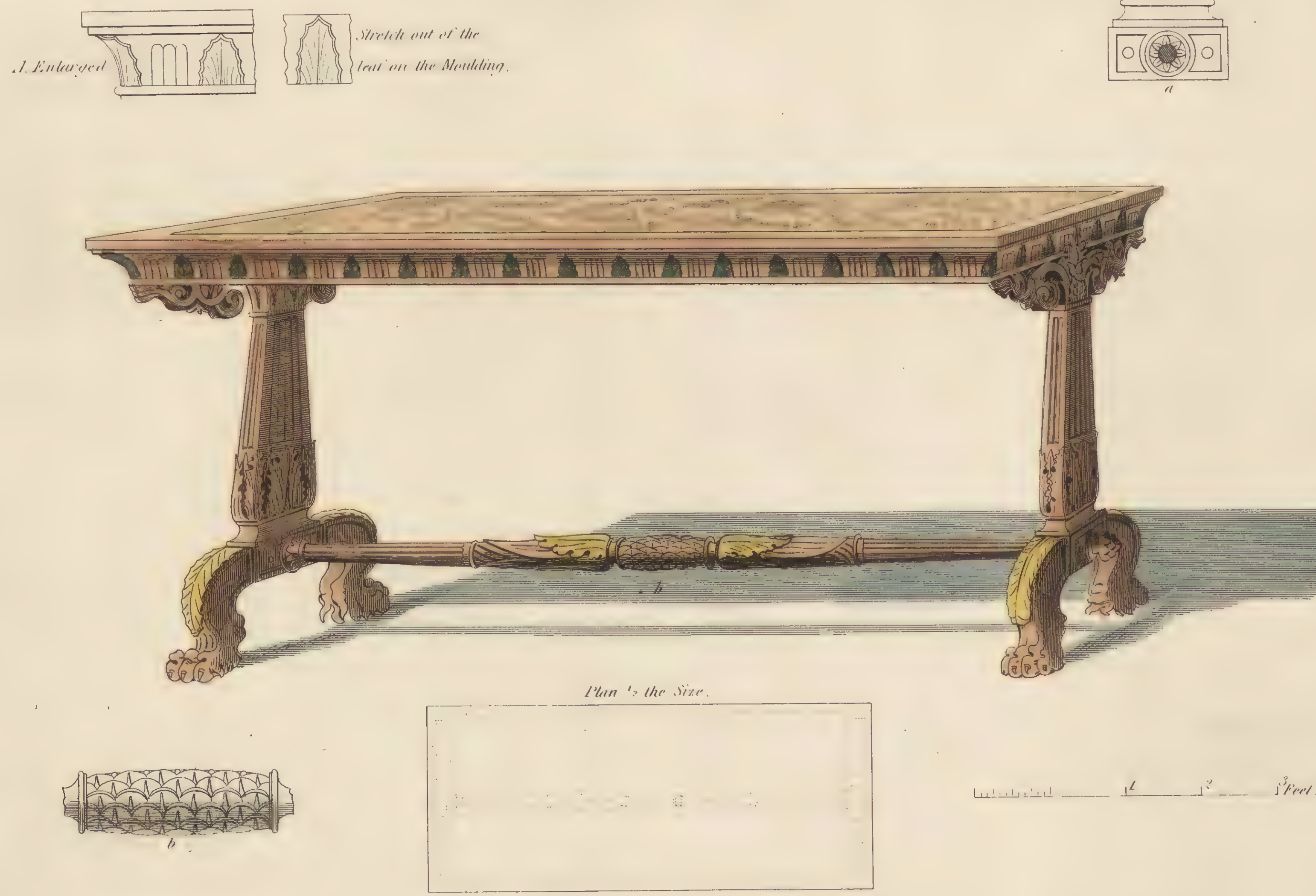
FISHER, SON, & Co LONDON 1833

Dressing Table and Dressing Glass.



Published by Fisher, Son & Co Caxton London Novr 18_1826

Occasional Table.



M. A. Nicholson. del.

J. Henshall. sc.

Published by Fisher, Son & Co. Caxton, London 1834.

Pier Table.

Fig. 1.

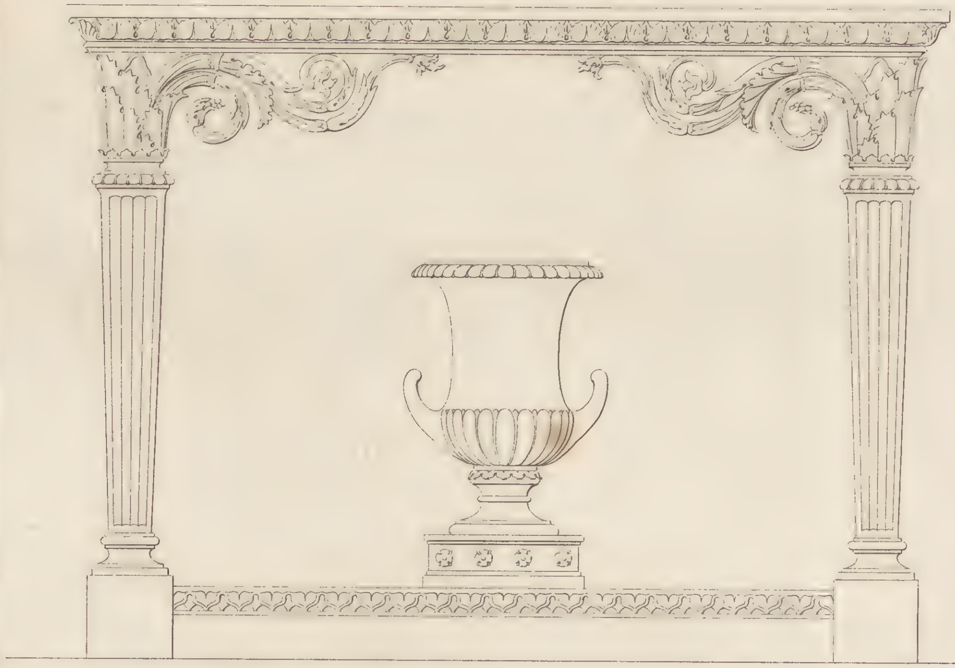
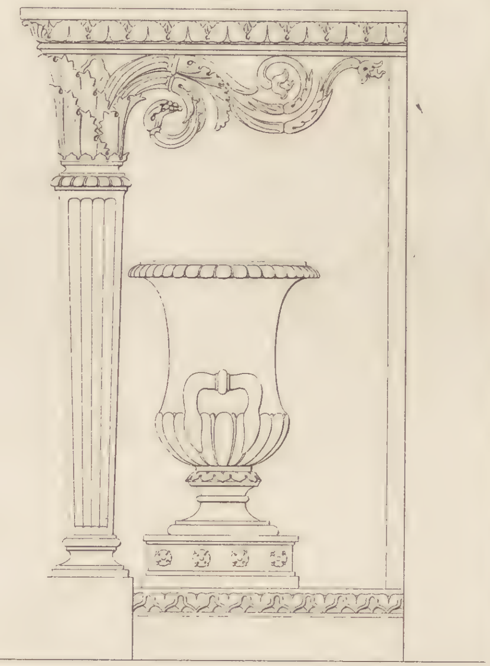


Fig. 2.



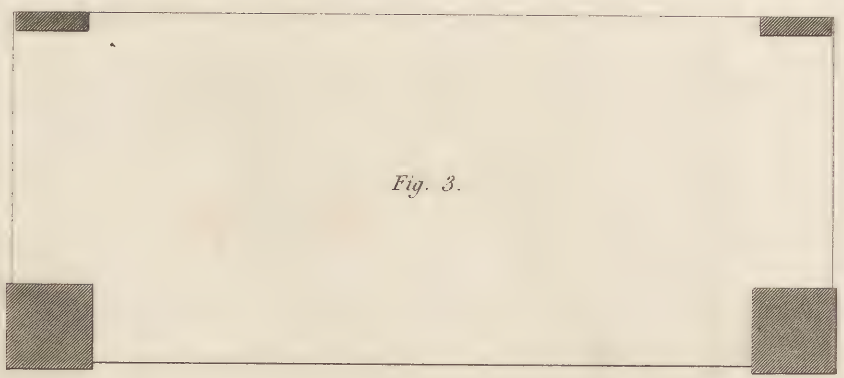
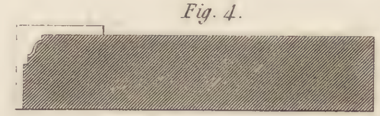


Fig. 3.

Fig. 4.



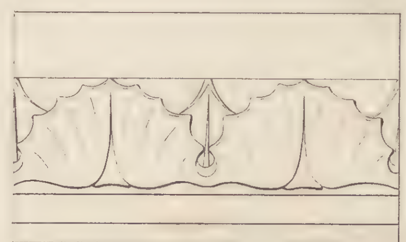


Fig. 5.

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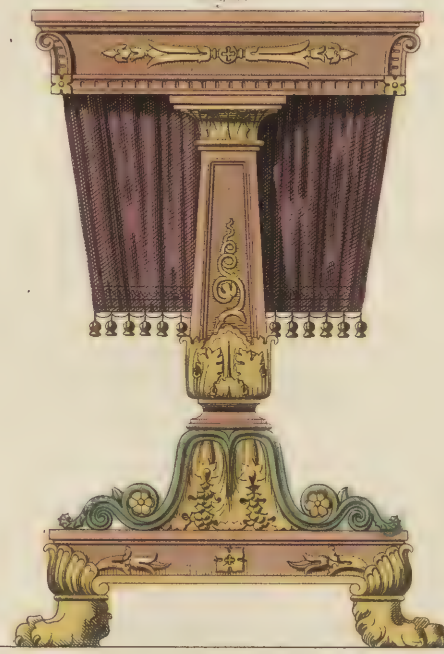
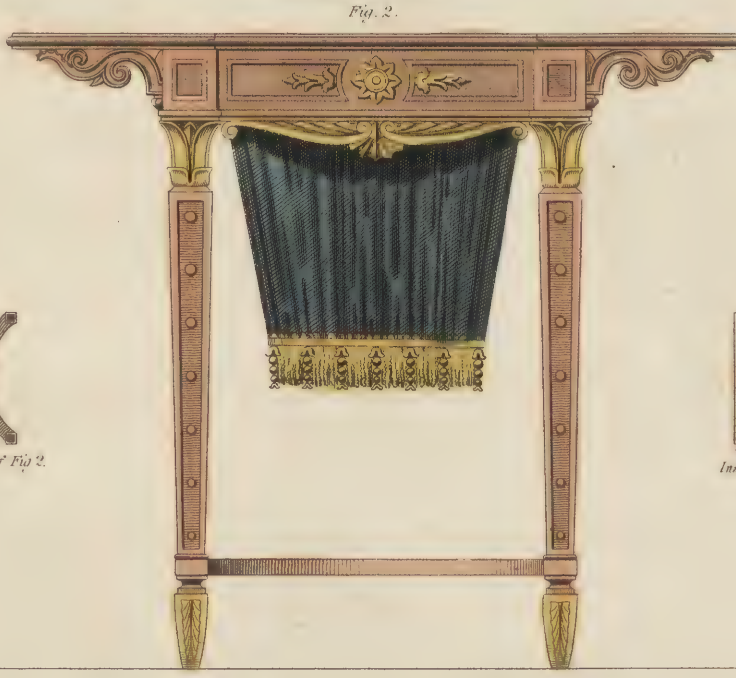
Ladies Work Tables.

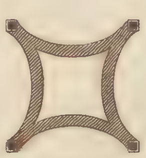
Fig. 1.



Backgammon Table.

Fig. 2.





Plan of lower part of Fig. 2.

Inside of Table of Fig. 2.

12 9 6 3 0 1 Foot.

Nicholson del.

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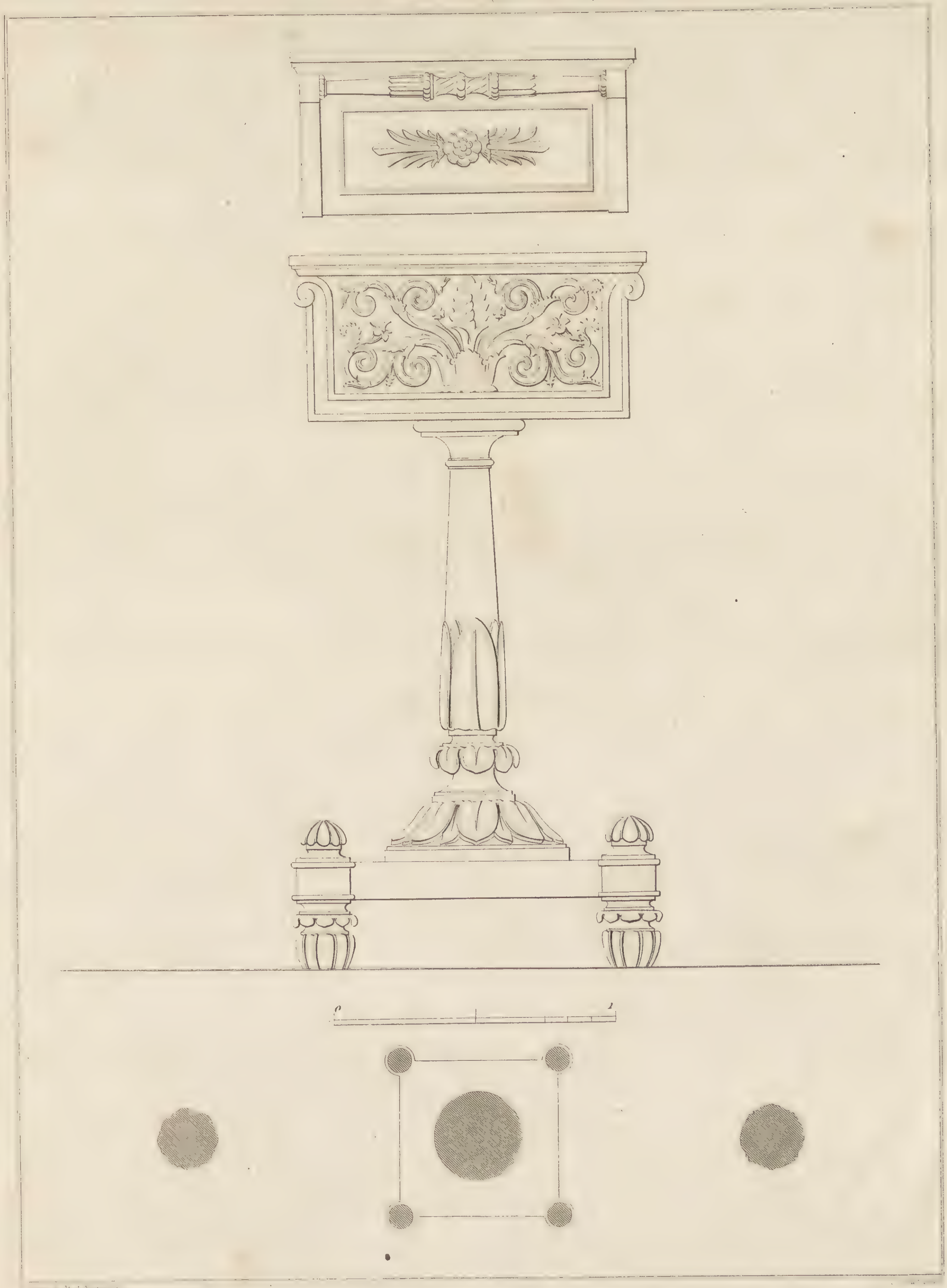
Tea Poy.



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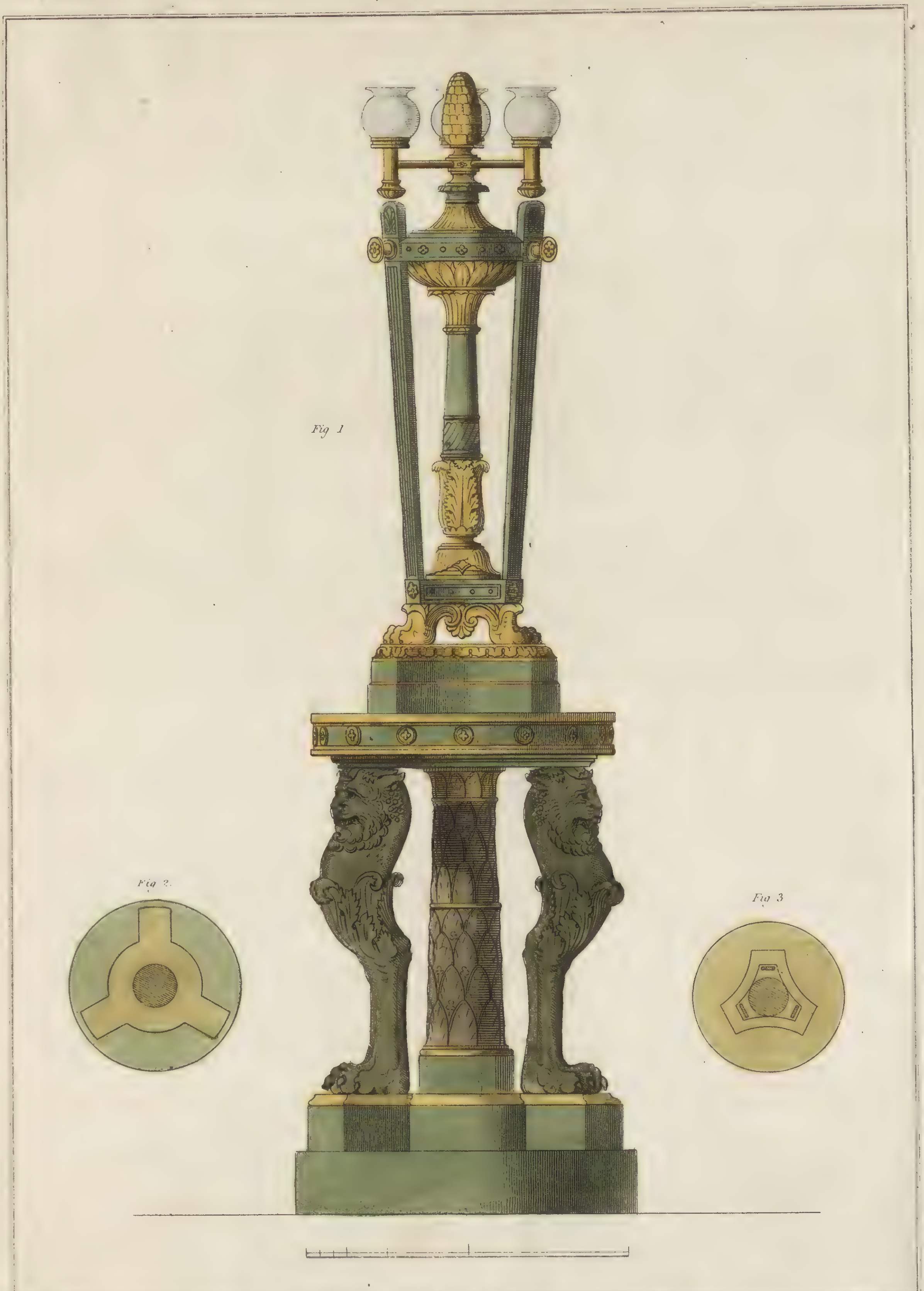
Tripod and Stand.



Designed by M.A. Nicholson

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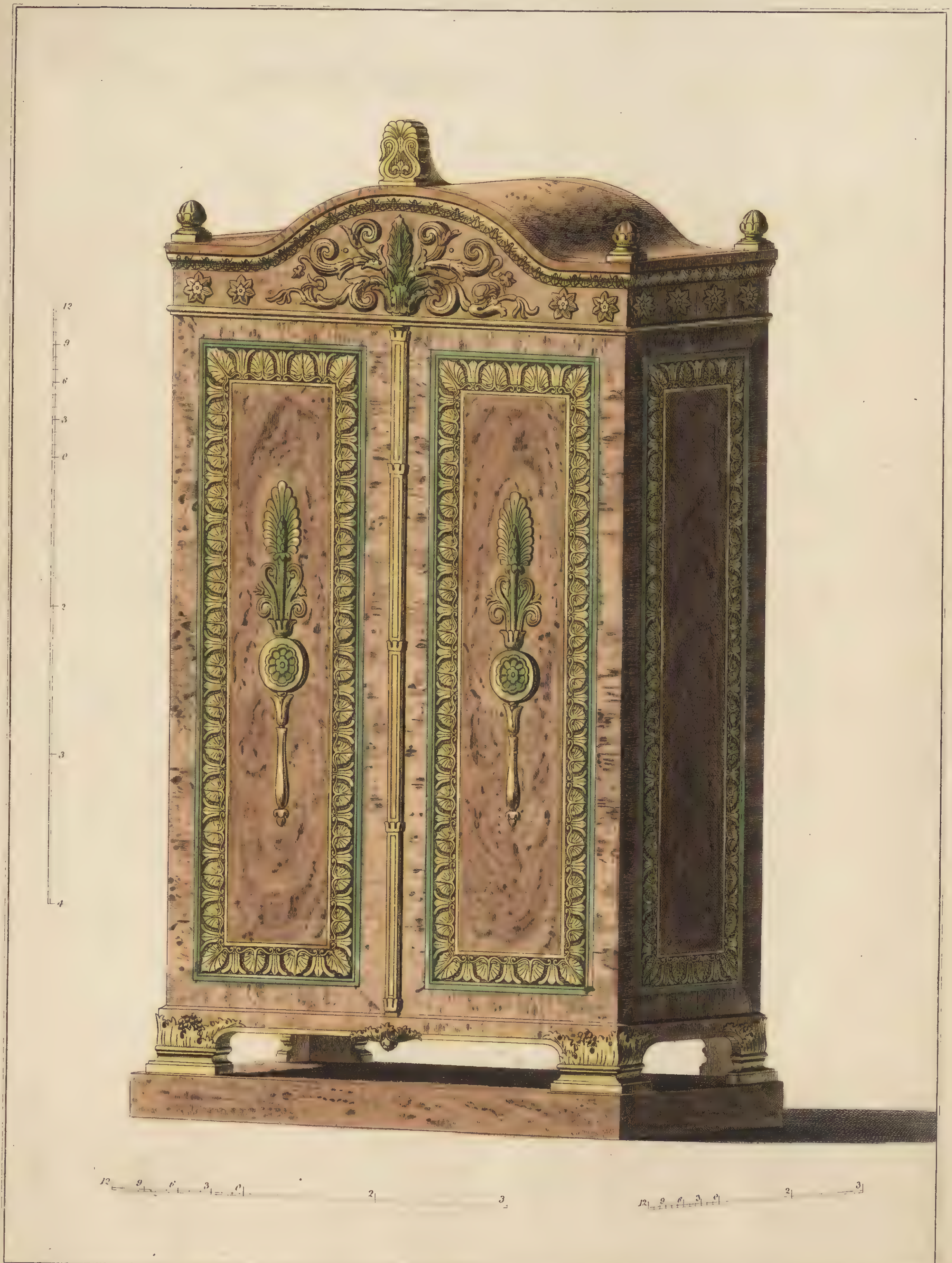
[illegible] Taylor London May 18[illegible]

Ladies' Wardrobe.



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